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Abstracts

HAYASHI, T.: **Endo-1,4-β-glucanases,** *In Glycoenzymes,* ed. M. Ohnishi, pp. 107–114, JSSP and Karger, Tokyo (2000).

Plant endo-1,4-β-glucanases are reviewed as various physiological aspects of plant growth, for example, loosening of the primary cell wall, vascular differentiation, leaf abscission, fruit ripening and symbiosis.

TAKEDA, T., F. SAKAI and T. HAYASHI: **A homologue of *EGL1* encoding endo-1,4-β-glucanase in elongating pea stems,** *Biosci. Biotech. Biochem.,* **64**, 636–640 (2000).

A gene *(EGL2)* encoding an endo-1,4-β-glucanase in peas has been cloned as a homologue of *EGL1*. *EGL2* encodes a polypeptide of 506 amino acids, including a 24-mer putative signal polypeptide. The gene product contains a domain conserved in endo-1,4-β-glucanase (family 9) showing 60% amino acid identity to *EGL1*. *EGL2* mRNA was accumulated only in the elongating regions of pea stems, although *EGL1* mRNA was abundant in both elongating and non-elongating tissues. However, the level of *EGL2* mRNA was not increased by the treatment with sucrose and auxin in pea segments. These results suggest that the expression of *EGL2* either requires the presence of other factors related to the auxin effect or occurs independent of auxin in the elongating pea stems.

HAYASHI, T.: **Xyloglucan oligosaccharides in plant cell enlargement,** *http://www.glycoforum.gr.jp/science/word/saccharide/SA-A04E.html* (2000).

Plant cell enlargement occurs due to the power of water suction, which is derived from the osmotic pressure of cell solutes. The power of water suction occurs due to the reduction of wall pressure, namely wall loosening. Although the mechanism of the loosening has not been clarified at a molecular level, auxin-induced cell enlargement has been proved to accompany xyloglucan degradation and solubilization. Studies on plant cell enlargements begin to reveal the mechanizm of xyloglucan degradation in the walls of growing plant cells.

NAKAI, T., N. TONOUCHI and T. HAYASHI: **Enhancement of cellulose production by expression of sucrose synthase in *Acetobacter xylinum,*** *Chemistry and Biology,* **37**, 643–644 (1999).

Higher plants efficiently conserve energy ATP in cellulose biosynthesis by expression of sucrose synthase, in which the high free energy between glucose and fructose in sucrose can be conserved and used for the synthesis of UDP-glucose. Here, we constructed a mutant SuSy to mimic phosphorylated SuSy and used it for bacterial cellulose synthesis.

OHMIYA, Y., F. SAKAI and T. HAYASHI: **Two cDNA clones for soluble (Accession No. D32166) and wall-bound (Accession No. AB025796) endo-1,4-β-glucanases in suspension-cultured poplar cells,** *Plant Physiol. (Plant Gene Register),* **120**, 634 (1999).

Suspension-cultured poplar *(Populus alba)* cells produce two distinct endo-1,4-β-glucanases, one of which is released in the extracellular culture medium and the other localized in their walls. Two cDNA clones, *PopCel1* and *PopCel2,* isolated from a poplar cDNA library were considered to encode the extracellular and the wall-bound endo-1,4-β-glucanases, respectively, from the deduced amino acid sequences. The products of these two genes contained domains conserved in endo-1,4-β-glucanase (family 9) showing 91.5% amino acid identity.

KURODA, H.: **New control strategies for pine wilt diseases,** *Wood Research Tech. Note,* No. **35**, 32–46 (1999).

The review article noted the points to be solved in the disease. It has also discussed on the control strategies of pine wilt diseases, and proposed an idea that genetic control of a secondary metabolite, i.e. stilbenoid, might be a key step to control this disease. This article was partly based on the report of a Monbusho Research Grant for the author.

KODAN, A., H. KURODA and F. SAKAI: **Characterization of stilbene synthase genes in Japanese red pine *(Pines densiflora),*** *Wood Research,* No. **86**, 34 (1999).

A cDNA library was constructed from the root of Japanese red pine seedlings. Three stilbene synthase cDNAs with full coding regions and twelve 5′ truncated stilbene synthase cDNAs were isolated from the cDNA library. The sequences determined suggest that the mRNAs may show different longevity or life time. They were analyzed by phylogenetic tree. One of the full coding cDNA was successfully expressed in *E. coli.*

KURODA, H. and K. KURODA: **Candidate genes involved in water pump of trees,** *Proceeding of International Symposium on Sap utilization,* pp. 61–68, Bifuka (2000).

The water conduit in a pine tree is irreversibly broken by the attack of pathogenic wood nematodes, while it is reversibly broken in intact pine trees. In order to discuss water refilling, we have searched possible biological molecules in the water transport. Among the possible molecules in water transport, it was first experimentally confirmed that a passive water channel, aquaporin, locates in a mature tree xylem.

SHIMADA, M.: **A new aspect of oxalic acid producing enzyme research derived from lignin biodegradation research—Roles of fungi in production and preservation of woods,** *Proceedings of the 44th lignin symposium,* Gifu, Japan, October 7–8, p. 59–64 (1999).

Retrospective viewpoints of lignin biodegradation research are described focusing on development of the first biomimetic example of heme enzyme (LiP and MnP) model catalysts for the one electron oxidation of lignin and bleaching of unbleached kraft pulps. A new aspect of oxalic acid involved in ligninolytic systems in white-rot fungi is discussed in relation to a possible role of the glyoxylate cycle which may commonly occur in a wide

variety of saprophytic, symbiotic, and edible mushrooms.

OBATAYA, E., T. UMEZAWA, F. NAKATSUBO and M. NORIMOTO : **The effects of water soluble extractives on the acoustic properties of reed *(Arundo donax* L.),** *Holzforschung,* **53**, 63–67 (1999).

The storage modulus (E') and the loss tangent (tan δ) of reed (*Arundo donax* L.) used for woodwinds were measured at 20°C and 60% relative humidity and the effects of water soluble extractives on these properties were discussed. The extractives increased both the E' and tan δ of reed. There was a linear relationship between the tand change and the weight loss due to extraction. By using an uniaxial theological model considering the anatomical structure of reed, the E' and tand of reed were described using the storage moduli, loss tangents, and volume fractions of bundle sheaths and parenchyma cells. It was suggested that the extractives in parenchyma cells increased the modulus of elasticity for parenchyma cells by 25% and reduced the relaxation time of parenchyma cells by a factor of three. The main constituents of extractives were glucose, fructose and sucrose.

OSAKABE, K., C. C. TSAO, L. LI, J. L. POPKO, T. UMEZAWA, D. T. CARRAWAY, R. H. SMELTZER, C. P. JOSHI and V. L. CHIANG : **Coniferyl aldehyde 5-hydroxylation and methylation direct syringyl lignin biosynthesis in angiosperms,** *Proceedings of the National Academy of Sciences, USA,* **96**, 8955–8960 (1999).

A central question in lignin biosynthesis is how guaiacyl intermediates are hydroxylated and methylated to the syringyl monolignol in angiosperms. To address this question, we cloned cDNAs encoding a cytochrome P450 monooxygenase (LsM88) and a caffeate *O*-methyltransferase (COMT) from sweetgum *(Liquidambar styraciflua)* xylem. Mass spectrometry-based functional analysis of LsM88 in yeast identified it as coniferyl aldehyde 5-hydroxylase (CAld5H). COMT expressed in *Escherichia coli* methylated 5-hydroxyconiferyl aldehyde to sinapyl aldehyde. Together, CAld5H and COMT converted coniferyl aldehyde to sinapyl aldehyde, suggesting a CAld5H/COMT mediated pathway from guaiacyl to syringyl monolignol biosynthesis via coniferyl aldehyde that contrasts with the generally accepted route to sinapate via ferulate. Although the CAld5H/COMT enzyme system can be mediate the biosynthesis of syringyl monolignol intermediates through either route, kcat/Km of CAld5H for coniferyl aldehyde was ~140 times greater than that for ferulate. More significantly, when coniferyl aldehyde and ferulate were present together, coniferyl aldehyde a noncompetitive inhibitor ($E_i = 0.59$ mM) of ferulate 5-hydroxylation, thereby eliminating the entire reaction sequence from ferulate to sinapate. In contrast, ferulate had no effect on coniferyl aldehyde 5-hydroxylation. 5-Hydroxylation also could not be detected for feruloyl-CoA or coniferyl alcohol. Therefore, in the presence of coniferyl aldehyde, ferulate 5-hydroxylation does not occur, and the syringyl monolignol can be synthesized only from coniferyl aldehyde. Endogenous coniferyl, 5-hydroxyconiferyl, and sinapyl aldehydes were detected, consistent with in vivo operation of the CAld5H/COMT pathway from coniferyl to sinapyl aldehydes via 5-hydroxyconiferyl aldehyde for syringyl monolignol biosynthesis.

LI, L., J. L. POPKO, T. UMEZAWA and V. L. CHIANG : **5-Hydroxyconiferyl aldehyde modulates enzymatic methylation for syringyl monolignol formation, a new view of monolignol biosynthesis in angiosperms,** *J. Biol. Chem.,* **275**, 6537–6545 (2000).

S-Adenosyl-L-methionine-dependent caffeate O-methyltransferase (COMT, EC2.1.1.6) has traditionally been thought to catalyze the methylation of caffeate and 5-hydroxyferulate for the biosynthesis of syringyl monolignol, a lignin constituent of angiosperm wood that enables efficient lignin degradation for cellulose production. However, recent recognition that coniferyl aldehyde prevents 5-hydroxyferulate biosynthesis in lignifying tissue, and that the hydroxylated form of coniferyl aldehyde, 5-hydroxyconiferyl aldehyde, is an alternative COMT substrate, demands a re-evaluation of the role of COMT during monolignol biosynthesis. Based on recombinant aspen *(Populus tremuloides)* COMT enzyme kinetics coupled with mass spectrometry analysis, this study establishes for the first time that COMT is in fact a 5-hydroxyconiferyl aldehyde O-methyltransferase (AldOMT), and that 5-hydroxyconiferyl aldehyde is both the preferred AldOMT substrate and an inhibitor of caffeate and 5-hydroxyferulate methylation, as measured by Km and Ki values. 5-Hydroxyconiferyl aldehyde also inhibited the caffeate and 5-hydroxyferulate methylation activities of xylem proteins from various angiosperm tree species. The evidence that syringyl monolignol biosynthesis is independent of caffeate and 5-hydroxyferulate methylation supports our previous discovery that coniferyl aldehyde prevents ferulate 5-hydroxylation and at the same time ensures a coniferyl aldehyde 5-hydroxylase (CAld5H)-mediated biosynthesis of 5-hydroxyconiferyl aldehyde. Together, our results provide conclusive evidence for the presence of a CAld5H/AldOMT-catalyzed coniferyl aldehyde 5-hydroxylation/methylation pathway that directs syringyl monolignol biosynthesis in angiosperms.

HATTORI, T., A. NISHIYAMA and M. SHIMADA : **Induction of L-phenylalanine ammonia-lyase and suppression of veratryl alcohol biosynthesis by exogenously added L-phenylalanine in a white-rot fungus *Phanerochaete chrysosporium,*** *FEMS Microbiology Letters,* **179**, 305–309 (1999).

Effects of exogenously added L-phenylalanine (L-Phe) on the activities of L-phenylalanine ammonia-lyase (PAL) and 3, 4-dimeth- oxybenzyl alcohol (veratryl alcohol, VA) biosynthesis in the ligninolytic culture of *Phanerochaete chrysosporium* were investigated. The increasing PAL activity was detected in the low nitrogen (LN)-culture but not in the high nitrogen (HN)-culture. The addition of L-Phe into the LN-culture caused 25-fold increase in the enzyme activity, which clearly shows that L-Phe, a substrate of the enzyme, served as an inducer of PAL. The increase in activity of PAL triggered by the nitrogen starvation was correlated withbiosynthesis of VA. However, PAL induced by the added L-Phe did not promote the VA biosynthesis but suppressed the

biosynthesis probably due to NH_4^+ released from L-Phe.

HATTORI, T., N. AKITSU, G.-S. SEO, A. OHTA and M. SHIMADA: **The production of organic acids during the symbiotic cultivation of *Pinus densiflora* associated with *Lactarius hatsudake*,** *Annual report of interdisciplinary research institute of environmental sciences,* **18**, 121–127 (1999).

The symbiotic cultivation system for *Pinus densiflora* seedling associated with *Lactarius hatsudake* was established in vermiculite containing glucose and yeast extract in vitro. Compared with non-inoculated control seedlings, seedlings inocultaed with *L. hatsudake* showed increase in total dry weight, seminal root length, and shoot length. Furthermore, lateral root length of *P. densiflora* seedling increased by the association with *L. hatsudake.* The metabolic changes focusing on the biosynthesis, biodegradation and/or utilization of organic acids during symbiosis between *P. densiflora* and *L. hatsudake* were examined. The total amounts of organic acids identified in the symbiotic culture was 1.9 times that in the culture of non-inoculated control seedling. Oxalic acid was major organic acid produced in the symbiotic culture.

NAGAI, Y., T. TOKIMATSU, T. HATTORI and M. SHIMADA: **A possible intramolecular electron transfer pathway of glyoxylate dehydrogenase in a brown-rot fungus *Tyromyces palustris,*** *Wood Research,* No. **86**, 35–36 (1999).

An intramolecular electron transfer pathway of glyoxylate dehydrogenase in a brown-rot fungus Fomitopsis palustris was spectrophotometrically investigated by use of FMN fragment and heme fragment derived from the enzyme by degestion with papain. The results suggest that the electron was transferred from glyoxylate to the FMN fragment first, then to the heme fragment, and finally to cytochrome *c* as an electron acceptor.

SUZUKI, S., T. UMEZAWA and M. SHIMADA: **Stereochemical selectivity in secoisolariciresinol formation by cell-free extracts from *Arctium lappa* L. ripening seeds,** *Wood Research,* No. **86**, 37–38 (1999).

Cell-free extracts from ripening seeds of *Arctium lappa* L. catalyzed the enantioselective formation of (−)-pinoresinol, (−)- lariciresinol and (−)-secoisolariciresinol from achiral coniferyl alcohol in the presence of NADPH and H_2O_2. The enantioselectivity of the lignan formation was opposite to that of the (+)-secoisolariciresinol formation catalyzed by cell-free extracts from petioles of the same plant species. This is the first report that indicates clearly that two enzyme preparations from different organs of a single plant species catalyzed the selective formation of different enantiomers of lignans, and strongly suggests that there were organ specific isozymes that catalyzed the secoisolariciresinol formation with different enantioselectivity in *A. lappa.*

HIROSE, E., S. KIMURA, T. ITOH and J. NISHIKAWA: **Tunic morphology and cellulosic components of pyrosomas, doliolids, and salps (Thaliacea, Urochordata),** *Biol. Bull.,* **196**, 113–120 (1999).

The morphology and cellulosic composition of the tunic was studied in pelagic tunicates (3 pyrosomas, 2 doliolids, and 13 salps) The tunic is transparent and gelatinous, consisting of an electron-dense cuticular layer with a fibrous tunic matrix. The thickness and density of the cuticular and of the tunic matrix differ from species to species. In some salps, the cuticular layer has numerous minute protrusions that are structurally identical to those found in several ascidians. Free mesencymal cells (tunic cells) are distributed in the tunic. Whereas the number of tunic cells in the pyrosomas is similar to that in ascidians, there are many fewer tunic cells in doliolids and salps. These difference may be caused by the different functions of the tunic in each group. The existence of cellulose in the tunic was confirmed using electron diffraction in all of the species studied so far. Their diffractograms indicate that the cellulose microfibrils consist of nearly pure $I\beta$ of the allomorph. These results show that tunic morphology and cellulosic composition are similar in ascidians and thaliaceans (pyrosomas, doliolids, and salps). The tunic is considered to be a homologous tissue in these animals, and their most recent common ancestor would have possessed this tissue.

KIMURA, S., W. LAOSINCHAI, T. ITOH, X. CUI and R. M. BROWN, JR.: **Immunogold labeling of rosette terminal cellulose synthesizing complexes in a vascular plant *(Vigna angularis),*** *Plant Cell,* **11**(11), 2075–2085 (1999).

The catalytic subunit of cellulose synthase is shown to be associated with the putative cellulose synthesizing complex in vascular plants (rosette TC). The catalytic subunit domain of *Acetobacter xylinum* was used to screen for a rice EST (D41261) from which a specific primer was constructed to run PCR using a cDNA library from a 24 DPA cotton fiber as a template. The catalytic region of cotton cellulose synthase was expressed in *E. coli,* and polyclonal antibodies were produced. Using a freeze-fracture replica labeling technique, the antibodies were specifically localized to plasma membrane complexes on the P-fracture face known as rosette TCs. Antibodies did not specifically label any globular or terminal structures on the E-fracture face. Immunogold coupled to goat anti-rabbit antibody provided the tag for visualization in the transmission electron microscope. Significant labeling of TC rosettes (gold 20 nm or closer to the edge of the rosette) occurred in 74% of 217 gold particles from 20 different cells. The control pre-immune sera showed labeling only on 2% of 98 gold particles from 8 different cells. These experiments confirm the long held hypothesis that the TC rosette is the site of cellulose synthase in vascular plants, proving that the enzyme complex resides within the structure first described by freeze fracture in 1980 by Mueller and Brown (*J. Cell Biol.,* **84**, 315–326). The data also provide independent proof that the Cel A gene for cellulose synthase published by Pear *et al.* 1996 (*Proc. Natl. Acad. Sci. USA,* **93**, 12637–12642) is, in fact, one of the genes for cellulose synthase in vascular plants.

ITOH, T.: **Anatomical description of Japanese hardwoods V,** *Wood Res. and Tech. Notes,* No. **35**, 47–175 (1999).

The anatomical characteristics of Japanese hardwoods classified from Clethraceae to Asclepiadaceae covering 101 species, 50 genera and 18 families are described. The photomicrographs of cross, radial and tangential sections

covering 101 species are also presented.

ITOH, T.: **Tree species of wood artifacts excavated from Sunairi-Iseki,** *"Sunairi-Iseki", Hyougokenn-Bunkazai-Cyousa-Houkoku,* No. **161**, Board of Education in Hyougo Prefecture, 141–152 (1997).

A great number of wooden artifacts has been excavated from "Sunairi-Iseki" in Hyougo prefecture which is equivalent to Nara and Heian era. Wood species of 245 wood artifacts were identified microscopically. The results are as follows: *Cryptomeria japonica* was the most abundant species and amounted to 164 pieces among 246 in total. *Chemaceyparis obtusa* was the second abundant species and amounted to 50 pieces. The other 15 species were identified.

ITOH, T.: **Tree species of wooden type kept in religious sect,** *Enryakuji-Mokkatsuji-Kankei-Shiryou-Chousa-Houkokusho,* Board of Education in Shiga Prefecture, 150–152, figures 328–363 (2000).

A large number of wooden types were discovered in Enryakuji-temple. The wood types of ninty four among 184 thousand pieces were microscopically identified. The wood species were *Prunus* sp. (77 pieces), *Betula* sp. (9 pieces), *Fagus* sp. (1 pieces), *Cryptomeria japonica* (1 pieces), unknown coniferous species (2 pieces) and unidentifyable (2 pieces).

HAFREN, J., T. FUJINO, T. ITOH, U. WESTERMARK and N. TERASHIMA: **Ultrastructural changes in the compound middle lamella of *Pinus thunbergii* during lignification and lignin removal,** *Holzforschung,* **54**, 234–240 (2000).

The structure of the middle lamella in *Pinus thunbergii* has been studied by the rapid-freeze deep-etching (RFDE) technique in combination with transmission electron microscopy (TEM). The ultrastructure of the compound middle lamella was studied in the early phases of the development of woody tissue in the cambial and differentiating xylem, before the heavy incrustation with lignin had occurred. Lignified middle lamella in the xylem was studied both directly and after delignification. It was found that the structure of the unlignified middle lamella in the cambium/developing xylem consists of a fine irregular network probably containing pectin and hemicellulose. As a result of lignin incrustation, the middle lamella becomes increasingly dense and the surface structure of the fully lignified middle lamella appeared to be compact and partly covered with globular structures. After delignification of the lignified middle lamella a thin network with a different structure was revealed. This network probably mainly consists of hemicellulose. No microfibrils of the type that occurs in the primary and secondary walls were found in the middle lamella.

FUJINO, T., Y. SONE, Y. MITSUISHI and T. ITOH: **Characterization of cross-links between cellulose microfibrils, and their occurrence during elongation growth in pea epicotyl,** *Plant & Cell Physiol.,* **41**(4), 486–494 (2000).

The occurrence and chemical nature of the cross-links between cellulose microfibrils in outer epidermal cell walls in *Pisum sativum* cv. Alaska was investigated by rapid-freezing and deep-etching technique coupled with chemical and enzymatic treatment. The cell wall in the elongating region of epidermal cells was characterized by the absence of the cross-links, while in the elongated region, the cell wall was characterized by the presence of cross-links. The cross-links remained in the cell wall of the elongated region after treatment with SDS electrophoresis sample buffer and treatment with 4% potassium hydroxide. After treatment with endo-1, 4-b-glucanase, which fragments xyloglucan, the cross-links were remarkably reduced from the cell wall of the elongated region. The endoglucanase treatment also reduced immunogold labeling of xyloglucan in the cell wall. The endoglucanase hydrolysate from the cell wall fraction of the elongated region gave spots of oligosaccharides in thin layer chromatography, which were identical to the spots of xyloglucan oligosaccharides produced by xyloglucanase from both the cell wall fraction and tamarind xyloglucan. These results indicate that the cross-links are made of xyloglucan. We discussed the possibility of cross-links involved in the control of mechanical properties of the cell wall.

ITOH, T.: **Wood identification,** In, *"Laboratory Manual in Wood Science",* The Japanese Society of Wood Science, ed., Buneido Press, 76–83 (2000).

The procedures how to identify wood species were described by aiming mainly for the laboratory course of students. The chapter is divided into four different sections: (1) identification of coniferous woods by naked eye, (2) identification of hardwoods by naked eye, (3) Identification of coniferous woods by microscope, and (4) identification of hardwoods by microscope.

KIMURA, S., D.-H. KIM, J. SUGIYAMA and Y. IMANISHI: **Vesicular self-assembly of a helical peptide in water,** *Langmuir,* **15**, 4461–4463 (1999).

The formation of a molecular assembly composed of a naturally occurring peptide with a helical structure was investigated. Gramicidin A, a 15-mer peptide antibiotic, was conjugated with poly(ethylene glycol) (PEG, average molecular weight 600). This peptide conjugate formed vesicles with an unilamellar membrane in water as shown by frozen-hydrated/cryo-transmission electron microscopy (cryo-TEM) observations. The peptide fragment adopted an antiparallel double-helix conformation. The vesicles of the gramicidin conjugate encapsulating PEG showed much greater stability than encapsulation by imyristoylphos-phatidylcholine liposomes with respect to resistance to collapse upon detergent addition. Since the peptide membrane core is constituted of the secondary tructured units, the peptide vesicles (named peptosomes) may be advantageous to functional membranes due to their highly regular structure.

IMAI, T., J. SUGIYAMA, T. ITOH and F. HORII: **Almost pure I_α cellulose in the cell wall of Glaucocystis,** *J. Struct. Biol.,* **127**(3), 248–257 (1999).

Crystalline features of cellulose microfibrils in the cell walls of *Glaucocystis,* Glaucophyta were studied by combined spectroscopy and diffraction techniques, and the results were compared with those of *Oocystis,* Chlorophyta.

Although these algae are grouped into two different classes, by the composition of their chloroplasts for instance, their cell walls are quite similar in size and morphology. The most striking features of their cellulose crystallites are that they have the highest cellulose I_α contents reported to date. Especially, the I_α fraction of cellulose from Glaucocystis was found to be as high as 90% from ^{13}C NMR analysis. The mode of preferential orientation of cellulose crystallites in their cell walls is also interesting; equatorial 0.53-nm lattice planes were oriented parallel to the cell surface in the case of *Glaucocystis,* while the 0.62-nm planes were parallel to the *Oocystis* cell surface. Such a structural variation provides another link to the evolution of cellulose structure, biosynthesis and bio-crystallization mechanism.

KIMURA, S., Y. MURAJI, J. SUGIYAMA, K. FUJITA and Y. IMANISHI.: **Spontaneous vesicle formation by helical glycopeptides in water,** *J. Colloid Interface Sci.,* **222**, 265–267 (2000).

Hydrophobic helical peptide molecules with a lactose unit at the C terminal, Nap-(Ara-Aib)$_n$-$NHCH_2CH_2NH$-Lac, were synthesized and their formation of self-assemblies in water was invesitigated. Nap-(Ara-Aib)$_n$-$NHCH_2CH_2NH$-Lac was spontaneously dispersed in water and formed aggregates of 70 nm diameter, shown by dynamic light scattering measurment. Cryo-TEM observation revealed that the aggregates took on a vesicular structure with a single membrane, The membrane is suggested to be composed of helical peptide molecules with an interdigitated antiparallel packing on the basis of circular dichroism and fluorescence measurements. On the other hand, the dodecapeptide formed a fibrous assembly, and the hexadecapeptide could not be dispersed in water.

HASHIMOTO, M., T. IKEGAMI, S. SEINO, N. OHUCHI, H. FUKADA, J. SUGIYAMA, M. SHIRAKAWA and T. WATANABE: **Expression and characterization of the chitin-binding domain of chitinase A1 from *Bacillus circulans* WL-12,** *J. Bacteriol.,* **182**(11), 3045–3054 (2000).

Chitinase A1 from *Bacillus circulans* WL-12 comprises an N-terminal catalytic domain, two fibronectin type III-like domains, and a C-terminal chitin-binding domain (ChBD). In order to study the biochemical properties and structure of the ChBD, $ChBD_{ChiA1}$ was produced in *Escherichia coli* using a pET expression system and purified by chitin affinity column chromatography. Purified $ChBD_{ChiA1}$ specifically bound to various forms of insoluble chitin but not to other polysaccharides, including chitosan, cellulose, and starch. Interaction of soluble chitinous substrates with $ChBD_{ChiA1}$ was not detected by means of nuclear magnetic resonance and isothermal titration calorimetry. In addition, the presence of soluble substrates did not interfere with the binding of $ChBD_{ChiA1}$ to regenerated chitin. These observations suggest that $ChBD_{ChiA1}$ recognizes a structure which is present in insoluble or crystalline chitin but not in chito-oligosaccharides or in soluble derivatives of chitin. $ChBD_{ChiA1}$ exhibited binding activity over a wide range of pHs, and the binding activity was enhanced at pHs near its pI and by the presence of NaCl, suggesting that the binding of $ChBD_{ChiA1}$ is mediated mainly by hydrophobic interactions. Hydrolysis of β-chitin microcrystals by intact chitinase A1 and by a deletion derivative lacking the ChBD suggested that the ChBD is not absolutely required for hydrolysis of β-chitin microcrystals but greatly enhances the efficiency of degradation.

SUGIYAMA, J. and T. IMAI: **Cellulose microfibrils - structure reflects biological mechanism,** *Cellulose Commun.,* **7**(1), 1–8 (2000).

Cellulose is synthesized by the coordinated action of enzymatic polymerization coupled with instant crystallization into nascent cellulose microfibrils far below its glass transition temperature. The mechanism allows generation of highly extended chains that can crystallize into microfibrils including two distinct crystalline moieties: cellulose I_α and I_β. This is what we believe quite distinct from the man-made fibers and I structure there seems to be imprints of many events of biological activities. Here, we report some links between structure and biological mechanisms or diversity at several different structural levels.

SUGIYAMA, J.: **Experimental manual for wood science,** *Jap Wood Res Soc. Ed.,* Chapter VI-4-1 (1999).

Experimental recipes for the X-ray diffractometry technique for the graduate school level are outlined.

OHYAMA, M., K. BABA, T. ITOH and S. SHIRAISHI: **Polymorphism analysis of Fagaceae and DNA-based identification of *Fagus* species grown in Japan based on *rbcL* gene,** *J. Wood Sci.,* **45**, 183–187 (1999).

Fagaceae species in Japan were identified by restriction fragment length polymorphism (RFLP) and sequence comparison of a region of *rbcL*. Of 9 restriction endonucleases used for digestion, three (M*sp*I, R*sa*I, H*ae*III) produced different restriction patterns in Fagaceae. Digestion by M*sp*I yielded four different patterns; *Fagus* species, *Castanea crenata, Pasania glabra,* and others. Digestion by R*sa*I and H*ae*III afforded two patterns; *Fagus* species and others. These facts indicate that *Castanea crenata* and *Pasania glabra* can be identified by M*sp*I restriction patterns of *rbc*L. Sequence comparison of a region of the *rbc*L gene among 20 species of Fagaceae showed that: (1) they could be divided into 7 groups; (2) there is a site mutation between *Fagus crenata* and *F. japonica*. The latter indicates that the wood of both *Fagus* species are identifiable at the species level, which is not the case using conventional methods. This result indicates a possibility of wood identification basing DNA polymorphism in Fagaceae at the intrageneric level.

OHYAMA, M., K. BABA and T. ITOH: **Possibility of grouping of *Cyclobalanopsis* species (Fagaceae) grown in Japan based on an analysis of several regions of chloroplast DNA,** *J. Wood Sci.,* **45**, 498–501 (1999).

Four regions of chloroplast DNA were sequenced as a prospective genetic marker to identify Japanese representatives of *Cyclobalanopsis: Quercus acuta, Q. sessilifolia, Q. salicina, Q. myrsinaefolia, Q. glauca* and *Q. gilva.* We found that *Q. gilva* was distinguished from other species based on both *trn*L-*trn*F and *trn*T-*trn*L intergenic spacer. The evidence shows good coincidence with the fact that *Q.*

gilva has several peculiar morphological features distinguishable from other species. There was no difference in trnL intron and *mat*K. Both *trn*T-*trn*L and *trn*L-*trn*F intergenic spacers are capable of being used as genetic markers to identify *Q. gilva* among *Cyclobalanopsis* species.

BABA, K., T. ASADA and T. HAYASHI: **The relation between developmental changes on anatomical structure and on protein pattern in differentiating xylem of tension wood,** *J. Wood Sci.*, **46**, 1–7 (2000).

Tension wood was induced in *Eucalyptus camaldulensis* L. by fixing the stem at an angle. Proteins in differentiating tissue of tension wood were compared to those of normal wood on SDS-PAGE. An obvious difference was found in the salt-soluble fraction of 14 d after inclination. At least 5 bands (19, 22, 37, 41, and 55 kDa) were specific in the differentiating tissue of tension wood. These proteins would bind to the cell wall and/or plasma membrane by their electric charge. These proteins were undetectable until 14 d after inclination. Mature tension wood was observed in the tissue of 14 d. Thus, all differentiating tissue in 14 d was born after inclination. On the other hand, the differentiating zone of 7 d contained the tissue estimated at tension wood by the vessel number and diameter in the early phase and the tissue undistinguishable from normal wood in the late phase. The proteins found here would be related to the phenomenon occurring on the late stage of xylem differentiation.

KAMITSUJI, H., Y. HONDA, T. WATANABE and M. KUWAHARA: **Studies on the production of manganese peroxidase by a white-rot fungus *Pleurotus ostreatus*,** *Wood Research*, No. **86**, 41–42 (1999).

Two different manganese peroxidase (MnP) isozymes were demonstrated to be secreted in liquid stationary culture of *P. ostreatus* using glucose/yeast-exract medium and pepton/glucose/yeast-extract medium. The enzymes were purified and characterized, separately. And determined N-terminal amino-acid sequence was compared to other MnP isozymes from white-rot basidiomycetes, such as *Pleurotus eryngii* or *Phanerochaete chrysosporium*.

KUWAHARA, M., H. ITOH, T. HIRANO, T. WATANABE and Y. HONDA: **Studies on the mechanism of degradation and dechlorination of toxic aromatic compounds by basiciomycetes and the application to bioremediation of polluted environment,** *Annual Report of Interdisciplinary Research Institute of Environmental Sciences*, **18**, 113–120 (1999).

Wood-rotting fungi which have been known as lignin-degrading organisms were screened for the activity applicable to the bioremediation of the soils polluted by toxic aromatic compounds used as fungicides, herbicides and other agricultural chemicals. Many strains of *Pleurotus ostreatus* which are used for commercial cultivation decolorized an azo dye, Azure B, and degraded 4-chlororesorcinol (4-CR) in the agar plate cultures. In the liquid cultures, chlorophenols such as 4-CR, 4-chlorocatechol, 2,4-dichlorophenol, *o*-, *m*- and *p*-chlorophenols were degraded and dehydrogenated effectively within 24 hours. Degradation of these chlorinated phenols was found to be correlated to the level of manganese (II) peroxidase activity in the culture, indicating this ligninolytic peroxidase was involved in the degradation of chlorinated phenols, as well as elimination of chlorine. Other basidiomycetes including *Bjerkandera adusta*, *Coriolus versicolor* and *C. hirsutus* were also found to be usable for the bioremediation.

WATANABE, T. and M. KUWAHARA: **Enzymatic degradation of lignin - Degradation of polymers by the oxidative radical reaction catalyzed by peroxidases,** Kagaku to Seibutu (Chemistry and Biology), **38**, 161–166 (2000) (in Japanese).

Recent advances in the research on the degradation of lignin and its related polymers by radical oxidation mechanism mediated by the ligninolytic peroxidases were reviewed.

WATANABE, T., H. KAMITSUJI, M. ENOKI, Y. HONDA and M. KUWAHARA: **The first evidence indicating formation of superoxide by manganese-dependent peroxidase (MnP) in the presence of excess H_2O_2,** *Chem. Lett.*, 444–445 (2000).

Production of O_2^- by manganese peroxidase (MnP) in the absence of free radical intermediates was analyzed by ESR spin trapping experiments with 4-POBN and DMPO. MnPs from *Pleurotus ostreatus* and *Bjerkandera adusta* produced O_2^- after addition of excess of H_2O_2 independently of the presence of organic acid chelator for Mn(II) and Mn(III). This is the first report demonstrating direct production of O_2^- by MnP.

KAJIKAWA, H., H. KUDO, T. KONDO, K. JODAI, Y. HONDA, M. KUWAHARA and T. WATANABE: **Degradation of benzyl ether bonds of lignin by ruminal microbes,** *FEMS Microbiol Lett.*, **187**, 15–20 (2000).

We examined microbial activity in the rumen to cleave benzyl ether bonds of lignin model compounds that fluoresced when the bonds were cleaved. 4-Methylumbelliferone veratryl ether dimer was degraded completely within 8 h even with fungicidal antibiotics, but no significant degradation occurred with bactericidal antibiotics. Degradation of a phenolic *β-O*-4 trimer incorporating 4-methylumbelliferone by a benzyl ether linkage was stimulated by ruminal microbes, although its corresponding non-phenolic model compound, 1-(4-ethoxy-3-methoxyphenyl)-1-*O*-(4-methylumbelliferyl)-2-(2-methoxyphenoxy)-3-propanol was not degraded. A coniferyl dehydrogenation polymer bearing fluorescent *β-O*-4 benzyl ether that contains both phenolic and non-phenolic benzyl ether bonds was partially degraded (about 20%) in 48 h. These results indicate that ruminal microbes decompose benzyl ether linkages of lignin polymers under anaerobic conditions.

ENOKI, M., T. WATANABE, S. NAKAGAME, Y. HONDA and M. KUWAHARA: **A novel fluorescent dicarboxylic acid, (Z)-1,7-nonadecadiene-2,3-dicarboxylic acid, produced by white-rot fungus *Ceriporiopsis subvermispora*,** *Chem. Lett.*, 54–55 (2000).

A novel fluorescent dicarboxylic acid bearing a long

alkenyl side chain, 7(Z)-1, 7-nonadecadiene-2, 3-dicarboxylic acid, was isolated from cultures of a white-rot fungus *Ceriporiopsis subvermispora*. This is the first report of microorganism that produces an amphiphilic itaconic acid derivative with a long aliphatic side chain.

ENOKI, M., T. WATANABE, S. NAKAGAME, K. KOLLER, K. MESSNER, Y. HONDA and M. KUWAHARA: **Extracellular lipid peroxidation of selective white-rot fungus, *Ceriporiopsis subvermispora*,** *FEMS Microbiol. Lett.*, **180**, 205–211 (1999).

Ceriporiopsis subvermispora is capable of decomposing lignin without penetration of enzymes into wood cell walls. To elucidate the mechanism of lignolysis at a site far from enzymes, peroxidation of low molecular mass compounds produced by this fungus was analyzed. *C. subvermispora* produced free 9, 12-octadecadienoic, 9-octadecenoic, 11-octadecenoic, hexadecanoic and octadecanoic acids, predominantly at an early stage of cultivation on wood meal cultures. In prolonged cultivation period after two weeks, the amount of intact fatty acids decreased with increasing in organic hydroperoxide and TBARS production. The production and oxidation of peroxidizable metabolites suggest that lignin-biodegradation by *C. subvermispora* is related to extracellular lipid peroxidation.

MESSNER, M., K. FACKLER, K. KOLLER, P. LAMAIPIS, E. SREBOTONIK and T. WATANABE: **Wood degradation by fungi,** *Biokonversion Nachwachsender Rohstoffe, Schriftenreiihe Nachwachsender Rohstoffe Vol. 15,* Landwirtshcftsverlag, Munich, 76–84 (1999).

Selective lignin-degradation by white rot fungi such as *Ceriporiopsis subvermispora* are reviewed. *In situ* free radical process necessary for the selective lignolysis and application of the radical process to biomimetic pulp bleaching are also described.

WATANABE, T.: **Quantitative determination of carbohydrate component,** Manual for wood science experiments, Bueido, Tokyo, 104–108 (2000) (in Japanese).

Experiments for the analysis of carbohydrate components in woody plants are described.

NAKAGAME, S., M. ENOKI, Y. HONDA, T. WATANABE and M. KUWAHARA: **Peroxidizable compounds produced by selective white-rot fungus, *Ceriporiopsis subvermispora*,** *Wood Research*, No. **86**, 45–49 (1999).

Ceriporiopsis subvermispora, the best biopulping fungus so far examined, is known to decompose lignin located in wood cell walls and middle lamellae without erosion of the wood cell walls even after fiber separation. It is plausible that the lignin-degradation of this fungus is catalyzed by low molecular mass oxidants generated near the substrate. In this study, the authors focused on a free radical generating system from peroxidizable compounds produced by *C. subvermispora*. When wood meal cultures of the fungus were extracted with CHC_3/MeOH after removal of water-soluble materials, free unsaturated fatty acid (USFA), 9, 12-octadecadienoic acid was detected, together with saturated fatty acid, hexadecanoic acid. These fatty acids were produced predominantly in the initial stage and the decreased with concomitnat production of liped hydroperoxide. A possible rule of the USFA in the selective lignin-biodegradation was discussed.

MATSUYAMA, T., Y. HONDA, T. WATANABE and M. KUWAHARA: **Development of a transformation system in white-rot fungus *Pleurotus ostreatus*,** *Wood Research*, No. **86**, 43–44 (1999).

A point mutation was introduced in wild-type *P. ostreatus sdi1* gene which encodes iron sulfer subunit of suucinate dehydrogenase of the mitochondrial complex II. Upon introduction to the protplasts, the modified gene confered dominant resistance to systemic fungicide, carboxin. The introduced sequence was detected by PCR amplification followed by restirction endonuclease digestion.

IRIE, T., Y. HONDA, H.-C. HA, T. WATANABE and M. KUWAHARA: **Isolation of cDNA and genomic fragments encoding the major manganese peroxidase isozyme from the white rot basidiomycete *Pleurotus ostreatus*,** *J. Wood Sci.*, **46**, 230–233 (2000).

We have isolated the cDNA and genomic sequences encoding the major isozyme of manganese peroxidase, MnP3, from the white rot basidiomycete *Pleurotus ostreatus* strain IS1. The gene, *mnp3*, is interrupted by ten introns and encodes a mature protein of 357 amino acids with a 26-amino-acid signal peptide. The amino acids known to be involved in peroxidase function, as well as those which form the Mn binding site in the *Panerochaete chrysosporium* MnP isozyme are conserved in MnP3. Comparison of the deduced primary structure of MnP3 with those of other peroxidases from various white rot fungi suggested that MnPs from *P. ostreatus* and *T. versicolor* belong to a subgroup which is more similar to the lignin peroxidases than MnPs from *P. chrysosporium* or *Ceriporiopsis subvermispora*.

HONDA, Y., T. MATSUYAMA, T. IRIE, T. WATANABE and M. KUWAHARA: **Carboxin resistance transformation of the homobasidiomycete fungus *Pleurotus ostreatus*,** *Curr. Genet.*, **37**, 209–212 (2000).

A novel selection marker gene for transformation of white-rot basidiomycete *Pleurotus ostreatus* was developed by introducing a point mutation in a gene which encodes iron-sulfur protein (Ip) subunit of succinate dehydrogenase. The mutant gene, Cbx^R, encodes a modified Ip subunit with an amino acid substitution (His239 to Leu) and confers resistance to the systemic fungicide, carboxin. The DNA sequence was integrated ectopically in the chromosome of the transformants and the drug resistance was inherited stably during mitotic and meiotic cell divisions. This is the first report of a homologous marker gene which is available for molecular breeding of an edible mushroom.

HONDA, Y., T. IRIE, T. WATANABE and M. KUWAHARA: **Molecular breeding of the oyster mushroom using a homologous DNA-mediated transformation system,** *In* Mushroom Science XV : Science and Cultivation of Edible Fungi, ed. van Griensven L.J.L.D., p. 151–156, Balkema, Rotterdam (2000).

Pleurotus ostreatus is a commercially important edible mushroom known as the oyster mushroom. It is also a white-rot fungus which is a good model for understanding biodegradation of plant cell wall lignin. We are interested in molecular breeding of the fungus using a homologous transformation system. A homologous marker gene would be maintained and expressed more stably than the heterologous and recombinant markers in the mushroom cells. Moreover, incorporation of a bacterial gene fragment, such as hygromycin B resistant gene, would have negative effects, especially for the breeding of edible mushrooms.

In this context, we have developed a homologous drug-resistance marker Cbx^R by introducing a point mutation in the *P. ostreatus sdi1* gene. Upon introduction to protoplasts, the marker gene conferred a dominant resistance to a systemic fungicide, carboxin. Transformants incorporating the marker DNA were easily selected on regenerating plates containing carboxin. The drug resistant phenotype was maintained stably during mitotic and meiotic cell divisions of the transformants. Through several efforts for increasing efficiency of the transformation, we have got about 200 transformants per μg of vector plasmid with a modified protocol for the transformation.

Using the transformation system, we also carried out homologous expression of recombinant manganese peroxidase *(mnp)* genes in *P. ostreatus*. Enhanced enzyme activity was observed in the early stage of liquid culture of the transformants. And predominant expression of the incorporated recombinant mnp gene was confirmed by competitive RT-PCR experiments. This is the first example of molecular breeding of an edible mushroom using homologous genetic elements.

HONDA, Y., T. MATSUYAMA, T. IRIE, T. WATANABE and M. KUWAHARA: **Carboxin resistant transformation of homobasidiomycete *Pleurotus ostreatus*,** *7th International Fungal Biology Conference,* Groningen, The Netherlands, August 22–25 p. 59 (1999).

Dominant drug resistance markers have been proved to be very useful for developing transformation systems in many organisms and avoid the need to isolate auxotrophic strains and clone the appropriate metabolic genes that will complement their defects. In *P. ostreatus,* it was reported that a recombinant plasmid containing *E. coli* hygromycin B phosphotransferase gene fused to *A. nidulans* expression signals transformed wild-type strains to hygromycin resistance and that the plasmid was maintained as an autonomously replicating plasmid in the cell. However, these events could not be reproduced in our laboratory. Generally, it is considered that, in homobasidiomycetes, expression of chimeric genes under the control of heterologous expression signals is not so efficient. Hence low expression of the marker gene could be a possible reason for the difficulty in transformation to hygromycin resistance. In this context, it has been desired to develop effective and reproducible transformation systems using a homologous marker gene. A successful approach to develop a drug resistant marker gene from a homologous genetic material was presented.

HONDA, Y., T. IRIE, T. MATSUYAMA, T. WATANABE and M. KUWAHARA: **Homologous DNA-mediated transformation of the oyster mushroom available for molecular breeding,** *Proceedings of the 3rd International Conference on Mushroom Biology and Mushroom Products,* Sydney, Australia October 12–16, 53–59 (1999).

In order to construct a self-cloning system which is available for molecular breeding of edible mushrooms, we developed a homologous drug resistant marker, using a mutant *P. ostreatus sdi1* gene. The gene encodes modified iron-sulphur protein (Ip) subunit of succinate dehydrogenase and confers resistance to a systemic fungicide carboxin. Recombinant *P. ostreatus* strains which overexpress one of its manganese peroxidase isozymes were also isolated using the transformation technique. This is the first report of the edible mushroom which has been modified genetically by means of a molecular breeding technique.

OBATAYA, E. and M. NORIMOTO: **Acoustic properties of a reed (*Arundo donax* L.) used for the vibrating plate of a clarinet,** *J. Acoust. Soc. Am.,* **106**(2), 1106–1110 (1999).

The effect of water-soluble extractives on the acoustic properties of a reed (*Arundo donax* L.) used for the vibrating plate of a clarinet was investigated at various relative humidities (RH). At low RH levels, the extractives enhanced the dynamic Young's modulus of the reed. This effect was reduced with increasing RH because of the deliquescence of extractives. It was suggested that the quality of the reed is improved by the extractives reinforcing its dry part. The extractives also increase the density and the internal friction of the reed remarkably. These might affect the frequency response of the reed to make the tone richer and softer. The tone quality of the reed lost by the removal of extractives was reproduced by impregnating the reed with glucose, which is the most abundant constituent of natural extractives.

OBATAYA, E., K. UMEMURA, M. NORIMOTO and Y. OHNO: **Viscoelastic properties of Japanese lacquer film,** *J. Appl. Poly. Sci.,* **73**, 1727–1732 (1999).

The storage modulus (E') and loss modulus (E'') of Japanese lacquer films were measured over a temperature range of -150 to 400°C. Three relaxation processes labeled α, β, and γ were detected at 80, -60, and -140°C, and their apparent activation energies (ΔE) were 63–91, 13, and 9 kcal/mol, respectively. These were attributed to the micro-Brownian motions of polymerized urushiol, the molecular motion related to the absorbed water, and the motions of methylene groups in the side chains, respectively. With aging at room temperature, the location of the α peak shifted to higher temperature and its ΔE value decreased. This result was ascribed to the autoxidative polymerization of urushiol. The E' of lacquer films increased with heat treatments at 100°C or above. When treated at temperatures below 200°C, the location of the α peak shifted to higher temperature, with a reduction in the ΔE value. Heat treatments at 200°C or above resulted in remarkable shrinkage and weight loss of films owing to the pyrolysis of lacquer constituents.

DWIANTO, W., T. MOROOKA, M. NORIMOTO and T. KITAJIMA: **Stress relaxation of sugi (*Cryptomeria japonica* D. Don) wood in radial compression under high temperature steam,** *Holzforschung,* **53**, 541–546 (1999).

To clarify the mechanism of the permanent fixation of compressive deformation of wood by high temperature steaming, stress relaxation and stress-strain relationships in the radial compression for sugi wood were measured under steam at temperatures up to 200°C. The stress relaxation curves above 100°C were quite different in shape from those below 100°C, showing a rapid decrease in stress with increasing temperature. In the stress-strain relationships measured above 140°C, the stress reduced as ore-steaming time increased when compared at the same strain. The recovery of compressive deformation (strain recovery) was decreased with steaming time and reached almost 0 in 10 min at 200°C. The relationship between the residual stress and the strain recovery at the end of relaxation measurements could be expressed by a single curve regardless of time and temperature. The permanent fixation of deformation by steaming below 200°C was considered to be due to chain scission of hemicelluloses accompanying a slight cleavage of lignin. In some cases, the increase in regularity of the crystalline lattice space of microfibrils or the formation of crosslinks between the cell wall polymers seemed to play an important role in the permanent fixation of compressive deformation.

DWIANTO, W., T. MOROOKA and M. NORIMOTO: **Method for measuring viscoelastic properties of wood under high temperature and high pressure steam conditions,** *J. Wood Sci.,* **45**, 373–377 (1999).

A method for measuring the viscoelastic properties of wood under high temperature and high pressure steam was developed using a testing machine with a built-in autoclave. A newly developed load cell capable of resisting a steam pressure of 16 kgf/cm^2 and a temperature of 200°C was installed in the autoclave. This load cell could be used to determine precisely the loads while steaming at temperatures from 100°C to 200°C. In addition to load-detection problems, it was necessary to avoid the nonuniform thermal degradation of wood during the measurement process under steaming at high temperatures. This nonuniform degradation could be minimized by shortening the time required for the wood to attain thermal equilibrium using specimens conditioned to the fiber saturation point. According to this method, a stress relaxation curve for sugi wood being compressed while ateaming at 180°C was obtained. The stress was seen to decrease rapidly with time, reaching almost zero at 3,000s.

MOROOKA, T.: **Rheological properties of wood under high temperature steam,** *Wood Research and Technical Notes,* No. **35**, 12–20(1999)

This article surveys recent results relating to the mechanism of the permanent fixation for the radial compression of wood by steam treatment. Firstly, the measurement of stress relaxation and stress-strain relationship in the radial compression of wood under steam were described. The relationship between the residual stress and the Sr at the end of relaxation measurement could be expressed by a single curve regardless of time and temperature. The mechanism of permanent fixation by steaming was different depending on the extent of Sr. Almost no chemical changes in the cell wall polymers occurred for $Sr > 0.93$. The reduction of Sr was caused by the release of stresses due to the degradation of hemicelluloses for $Sr = 0.93$–0.60. The increase in the regularity of crystalline lattice spacing of the microfibrils or the formation of cross-linkages between the cell wall polymers resulted in fixation for $Sr = 0.60$–0.20. The decomposition of hemicelluloses as well as lignin caused perfect fixation for $Sr < 0.20$. Secondly, the results of creep measurements were described. The creep compliance curves for 30 min (I) and those with pre-steaming for 30 min (II) were well connected at 30min when the structural changes due to the degradation of hemicelluloses or the decomposition of lignin as well as hemicelluloses occurred. However, curve (I) at 30 min differed markedly from curve (II) when the structural changes due to the increase of the regularity of crystalline lattice spacing of the microfibrils or the formation of cross-linkages between the cell wall polymers occurred. It was concluded that these two kinds of structural changes could be detected well by creep measurement.

OBATAYA, E. and M. NORIMOTO: **Mechanical relaxation processes due to sugers in cane (*Arundo donax* L.),** *J. Wood Sci.,* **45**, 378–383 (1999).

The storage modulus and the mechanical loss tangent of untreated, extracted, and sugar-impregnated canes were measured over a temperature range of −150 to 0°C at low frequencies. Two relaxation processes, labeled α and β, were detected in the ranges −60 to 0°C and −120 to −100°C, respectively. The α and β processes shifted to lower temperatures with increasing moisture content. The α process was detected only in the canes containing sugar. The magnitude of its loss peak increased with an increase in sugar content. It was speculated that the α process was due to some interactive molecular motions of the adsorbed water and sugar. The β process, detected in all of the canes, was attributed to the motion of the adsorbed water in the amorphous cell wall substances.

DWIANTO, W., T. MOROOKA and M. NORIMOTO: **Compressive creep of wood under high temperature steam,** *Holzforschung,* **54**, 104–108 (2000).

Creep compliance curves in the radial compression were measured under steam for sugi *(Cryptomeria japonica)* at temperatures up to 200°C. The creep compliance curves for 30 min (I) and those with pre-steaming for 30 min (II) were well connected at 30 min when the structural changes due to the degradation of hemicelluloses or the decomposition of lignin as well as hemicelluloses occurred. However, the creep curves (I) at 30 min differed markedly from creep curves (II) when the structural changes due to the increase in regularity of crystalline lattice spacing of the microfibrils or the formation of cross-linkings between the cell wall polymers occurred. It was concluded that two kinds of structural changes could be detected well by creep measurement.

NAKANO, T., J. SUGIYAMA and M. NORIMOTO: **Contractive force and transformation of microfibril with aqueous sodium hydroxide solution for wood,** *Holzforschung,* **54**, 315–320 (2000).

The mechanism of longitudinal contraction of Yezo spruce *(Picea jezoensis)* during treatment with aqueous NaOH solution is discussed. The contraction of wood samples increased with an increase in the concentration of NaOH solution and in heating temperature. Measurements of the stress relaxation and the twist angle during the alkali treatment showed that the alkali treatment caused the contractive and twist forces of a trachaid cell wall in longitudinal and tangential directions, depending on the components of contractive force. The temperature dependence of the contraction and the thermodynamics led to the conclusion that the longitudinal contraction of samples is due to that of microfibrils via an entropy-elastic force.

OBATAYA, E., F. TANAKA, M. NORIMOTO and B. TOMITA: **Hygroscopicity of heat-treated wood I, Effects of after-treatments on the hygroscopicity of heat-treated wood,** *Mokuzai Gakkaishi,* **46**(2), 77–87 (2000).

Effects of heat-treatments and various after-treatments on hygroscopicity of wood were investigated. By heat treatments at 140, 160, 180 and 200°C for 8 hours, equilibrium moisture contents of hinoki wood specimens were reduced remarkably. However, moisture contents of heat-treated woods were fairly recovered by moistening at 25°C and 100% relative humidity for 2 weeks, steaming at 95°C for 12 hours, or boiling for an hours. Amounts of active adsorption site calculated by using Hailwood-Horrobin's adsorption equation were reduced remarkably by the heat treatments, but the reduction was almost recovered to their origunal level by after treatments. It was suggested that some temporary structure formed by heat treatment suppressed the water adsorption at low relative humidities, whereas it disappeared with scission of hydrogen bonds and mobilization of amorphous molecules at high relative humidities. The changes in the hygroscopicity due to heat treatments and after treatments could not be explained with those in the relative crystallinity determined by the X-ray diffraction. Thus, it was considered that the irreversible reduction of hygroscopicity was not due to recrystallization of cellulose, but mainly due to chemical changes of amorphous substances.

WATANABE, U., M. NORIMOTO and T. MOROOKA: **Cell wall thickness and tangential Young's modulus in coniferous early wood,** *J. Wood Sci.,* **46**, 109–114 (2000).

To investigate the effect of wall thickening around cell corners on the tangential Young's modulus of coniferous early wood, tapered beam cell models in which the variation of the cell wall thickness in the axial direction was taken into account were conducted for seven species. Their tangential Young's moduli were compared with the experimental results. The calculated Young's moduli of tapered beam cell models were larger than those of the models composed of the cell walls with uniform thickness, although both models showed almost the same density. For some species the calculated Young's moduli of the models in which the cell wall thickness increased curvilinearly in the axial direction were much closer to the experimental values. The reduction of the radial cell wall deflection due to the increase of the stiffness around cell corners was considered to increase the tangential Young's modulus of a wood cell.

OBATAYA, E., M. NORIMOTO and B. TOMITA: **Moisture dependence of vibrational properties for heat-treated wood,** *Mokuzai Gakkaishi,* **46**(2), 88–94 (2000).

In order to clarify effects of heat treatment on vibrational properties of wood, the specific dynamic Young's modulus (E/γ) and loss tangent ($\tan\delta$) in longitudinal direction of spruce wood specimen were measured at 25°C and various relative humidities before/after heat treatment at 160°C for 8 hours. Although it has so far been reported that the Young's modulus of air-dry wood can be enhanced with the heat treatment involving recrystallization of cellulose, E/γ values of heat-treated specimen were evidently lower than those of untreated ones at the same moisture content. This fact indicated that a degradation of cell wall constituents due to the heat-treatment reduced the Young's modulus of cell wall even when recrystallization of cellulose is promoted. It was speculated that the increase in E/γ as previously reported was caused by temporary reduction in the equilibrium moisture content due to the heat treatment. On the other hand, $\tan\delta$ values of untreated and treated specimens showed a maximum at about 3% moisture content. These peaks were explained by a presence of mechanical relaxation process which appeared at −50°C and shifted to lower temperatures with increasing moisture content. Since temperature location, $\tan\delta$ peak value, and apparent activation energy of the relaxation process remained almost unchanged by the heat treatment, it was suggested that the heat treatment had little influence on molecular motions of amorphous cell wall substances at low moisture contents.

YOKOYAMA, M., K. KANAYAMA, Y. FURUTA and M. NORIMOTO: **Mechanical and dielectric relaxations of wood in a low temperature range III, Application of sech law to dielectric properties due to adsorbed water,** *Mokuzai Gakkaishi,* **46**(3), 173–180 (2000).

To discuss the mechanism of dielectric relaxation due to motions of water molecules adsorbed on wood, the sorption isotherm at 20°C and the longitudinal dielectric properties of hinoki *(Chamaecyparis obtusa)* wood were measured. The measurements of dielectric properties were conducted in temperature range from −150°C to 0°C (5°C intervals) and in the frequency range from 1 kHz to 1 MHz (31 frequencies). The number of adsorbed water molecules involved in a proposed element cell wall model was estimated at various relative humidities. A parameter which measures the width of the distribution of relaxation time and thermodynamic quantities were calculated by applying a sech equation and the theory of rate processes to the relationship between the dielectric loss due to the adsorbed water and frequency. The distribution of relaxation time narrowed with increasing moisture content (m.c.). It was independent of temperature above 9.5%m.c. and the time-temperature superposition principle was applicable to the normalized dielectric loss-

frequency curves. With increasing m.c., the enthalpy and entropy of activation decreased up to 9.5%m.c. and then increased. These results were discussed in relation to the state of adsorbed water in the cell wall.

NOMURA, T.: **Bamboo Utilization in Myanmar,** *Wood Research,* No. **86**, 9–18 (1999)

There are much storage of the bamboo in Myanmar. However, this bamboo resources has not been utilized effectively and left until now. In this review, the present state of the bamboo resources in Myanmar is described, and also the effective utilization of the bamboo resources by smoke heat treatment and charcoal making are described.

NOMURA, T.: **Function of the bamboo charcoal and the bamboo vinegar (1),** *Tikutann and Tikusakueki,* **1**, 31–45 (1999)

In this review, following items were described. (1) Internal structure of the charcoal and its adsorptive and desorptive function. (2) The relationship between firing temperature of the bamboo charcoal and function of the charcoal. (3) The effect of the far infrared radiation of the charcoal.

KAWASAKI, T., M. ZHANG and S. KAWAI: **Sandwich panel of veneer-overlaid low-density fiberboard,** *J. Wood Science,* **45**(4), 291–298 (1999).

Low-density sandwich panels of veneer-overlaid fiberboards were manufactured at densities of 0.3–0.5 g/cm^3. The effect of board density, veneer thickness, and resin content on the fundamental properties of the panels were examined.

HANG, G., K. UMEMURA, S. KAWAI and H. KAJITA: **Improvement mechanism of bondability in UF-bonded reed and wheat straw boards by silane coupling agent and extraction treatments,** *J. Wood Science,* **45**(4), 299–305 (1999).

The effects of silane coupling agents and extractives on the wettability of reed and wheat straws were investigated and the improvement mechanism of bondability of boards manufactured from these materials was discussed.

UMEMURA, K., A. TAKAHASHI and S. KAWAI: **Durability of isocyanate resin adhesives for wood II. Effect of the addition of several polyols on the thermal properties,** *J. Applied Polymer Science,* **74**, 1807–1814 (1999).

The thermal properties of isocyanate (IC) resins prepared with a small amount of polyether polyols and water were investigated. The bond strengths of 3-ply plywoods glued with theses polyol-containing IC resins were measured as well, and the durability of the resins was discussed.

WONG, E.D., M. ZHANG and S. KAWAI: **Formation of the density profile and its effects on the properties of particleboard,** *Wood Sci. & Technol.,* **33**, 327–340 (1999).

Two types of particleboards, one with uniform vertical density profile and the other with conventional U-shaped profile were fabricated to various density levels, and the fundamental relationships between the density profile and the board properties were determined.

SUZUKI, S., M. IKEDA, H. INOUE, T. SHIBUSAWA and S. KAWAI: **Durability performance of laboratory-made OSB and some wood-based panels subjected to outdoor exposure,** *Wood Preservation,* **25**(6), 263–270 (1999) (in Japanese).

Various wood based panels were tested in outdoor exposure to evaluate their performance of durability.

MURAKAMI, K., M. UEDA, H. MATSUDA, M. ZHANG, T. KAWASAKI and S. KAWAI: **Manufacture and properties of three-layered particleboards with oriented face strands of veneers I. Effects of face strand/core particle ratios, resin types and resin contents on the board properties,** *Mokuzai Gakkaishi,* **45**(5), 395–402 (1999) (in Japanese).

Composite boards with three-layered structures were manufactured from oriented face strands of veneer and core particles of commercial particleboards. The effects of the face strands to core particle ratios, the resin type and contents on the properties of boards were examined.

NAKATA, K., H. SUGIMOTO, M. INOUE and S. KAWAI: **Development of compressed wood fasteners for timber construction III. Bearing characteristics of compressed LVL plate with a drift-pin,** *Mokuzai Gakkaishi,* **46**(1), 37–46 (2000) (in Japanese).

Veneers of sugi were impregnated with low-molecular weight phenolic resin and converted into compressed laminated veneer lumber. Tension-type bearing strength tests of drift-pin joints were made to evaluate the effect of end-distance, edge-distance, and loading angle on bearing characteristics.

HERMAWAN, D., T. HATA, K. UMEMURA, S. KAWAI, S. KANEKO and Y. KUROKI: **New technology for manufacturing high strength cement-bonded particleboard using super critical carbon dioxide,** *J. Wood Science,* **46**, 85–88 (2000).

The injection of carbon dioxide (CO_2) gas during pressing is one of the methods currently being applied to reduce the pressing (setting) time of cement. However the disadvantages of this method include the almost similar board properties as those produced by conventional method, and requirement of at least 14 days to achieve complete curing. This research achieved to improve the quality of cement-bonded particleboard and to reduce its curing time using a conventional cold-pressing method for setting the cement followed by curing treatment using supercritical CO_2.

TAKATANI, M., H. ITO, S. OHSUGI, T. KITAYAMA, M. SAEGUSA, S. KAWAI and T. OKAMOTO: **Effect of lignocellulosic materials on the properties of thermoplastic polymer/wood composites,** *Holzforschung,* **54**, 197–200 (2000).

The effect of lignocellulosic materials on the board performance of thermoplastic polymer/wood composites was examined by using softwood flours of 20-mesh- and 120-mesh-pass, steam exploded beech flour, and two kinds

of thermoplastic polymers, polyvinyl chloride and polystyrene.

OHNISHI, K., Y. OKUDAIRA, M. ZHANG and S. KAWAI: **Manufacture and properties of oriented medium density fiberboard from non-wood lignocellulosic fibers I. Development of a mechanical orientor and its application to manufacturing oriented fiberboard,** *Mokuzai Gakkaishi,* **46**(2), 115–124 (2000) (in Japanese).

A mechanical orientor for aligning long lignocellulosic fibers was newly developed for oriented medium density fiberboard production. Kenaf bast fiber and oil palm empty fruit bunch fiber were used in the experiments for examining the performance of the orientor.

HAYASHI, T., A. MIYATAKE and S. KAWAI: **Effects of outdoor exposure on the strength distribution of oriented strand board (OSB) and particleboard,** *J. Soc. Mat. Sci. Jpn.,* **49**(4), 384–389 (2000).

The outdoor exposure tests and strength tests of OSB and particleboards were conducted to study the mechanism of strength degradation of wood based panels.

NAKATA, K., H. SUGIMOTO, M. INOUE and S. KAWAI: **Development of compressed wood fasteners for timeber construction IV. Moment resistance of a joint model with a compressed LVL plate and effect of reinforcement by glass fiber sheets,** *Mokuzai Gakkaishi,* **46**(1), 37–46 (2000) (in Japanese).

To evaluate the moment resistance of compressed LVL plates, moment resisting drift pin joint models simulating beam column joints were tested.

KAWAI, S., M. ZHANG, L. MA and M. OKUMA: **Manufacture and properties of UF resins/cement bonded particleboards from melaleuca,** Proc. Intern'l Workshop on Sustainable Utilization of Regional Resources, p. 29–34, June 12–13, Tokyo 01999).

Particleboards bonded with UF resin and cement, respectively, were manufactured from melaleuca and their properties were examined.

EUSEBIO, D. A. and S. KAWAI: **Environment friendly technology, panel products from sugarcane,** Bagasse; Proc. Intern'l Workshop on Sustainable Utilization of Regional Resources, p. 35–39, June 12–13, Tokyo (1999).

Technical feasibility of sugar cane bagasse for the production of cement bonded particleboard by heat application was investigated.

SUBYAKTO, T., HATA, S. KAWAI, Y. IMAMURA and I. IDE: **Anisotropic thermal properties of molded carbon phenolic spheres,** *J. Wood Science,* **46**, 16–21 (2000).

Anisotropy in thermal properties of molded carbon phenolic spheres (molded CPS), the mixture of sugi wood charcoal powders with phenol formaldehyde resin molded with a hot press, were investigated. The effects of carbonized temperature, particle size of chars and density of the carbon phenolic spheres (CPS) on the thermal properties were discussed. The molded CPS specimens were measured for their thermal properties using laser flash method in both horizontal and vertical directions. The configuration of the CPS was observed by a scanning electron microscope (SEM). Anisotropy of the thermal properties (thermal diffusivity and thermal conductivity) between horizontal and vertical directions of the molded CPS was much higher compared to uncarbonized molded phenolic spheres. Therefore, converting wood into molded CPS is an effective way to enhance the thermal-anisotropy properties. More remarkable effects of carbonized temperature, particle size and density were observed in the horizontal compared to the vertical directions. Anisotropy characteristic in thermal properties of the molded CPS may be taken as an advantage to develop a new fire-retardant material for wood composites.

KAWAI, S., M. OKUMA, G. MESHITUKA and K. IIYAMA: **Sustainalbe Utilization of melaleuca in Naratiwat Province in southern Thailand—A proposal for community based level wood industry,** Proc. the International Symposium "Can Biological Production Harmonized with Environment?", p. 79–82, October 19–20, Tokyo (1999).

Annual growth of melaleuca in Naratiwat province of Thailand was estimated and the wood insudtry using melaleuca resources was discussed and wood wool cement board was recommended as the product of this community based small-scale wood industry for the sustainable utilization of melaleuca.

WONG, E. D., A-K. RAZALI and S. KAWAI: **Properties of MDF manufactured from juvenile *Hevea brasiliensis* materials,** Proc. the International Symposium "Can Biological Production Harmonized with Environment?", p. 95–98, October 19–20, Tokyo (1999).

Juvenile rubberwood was used for manufacturing medium density fiberboard and the properties were examined.

KAGEMORI, K., K. UMEMURA, T. YOSHIMURA, M. INOUE, S. KAWAI, K. YANO, S. FUTATSUGAWA and Y. NAKAMURA: **Identification of urushi coated films taken from ancient buddha images by using PIXE, FT-IR, and organic elemental analysis,** *Intern'l J. of PIXE,* 9, 3 & 4, p. 465–473 (1999).

Six types of samples including urushi, urushi tree and black coating films taken from ancient Buddha images were examined by analyses of PIXE, organic element and FT-IR to identify with urushi or another material.

KAWAI, S.: **Development of kenaf boards,** Rep. for the 20th Meeting of Wood Adhesion Res. Group of Jpn. Wood Res. Soc., Oct. 14, Noshiro (1999) (in Japanese).

The oriented kenaf bast fiaberboard was developed by using a mechanical orientor and the properties were examined. The composite boards with the kenaf-core praticleboard as a core and the oriented fiberboard as faces were manufactured as well.

KAWAI, S.: **The development of a new processing system for domestic small-diameter logs,** Textbook of 2nd Wood Proceesign Tech. Conf. of Toyama Pref., Feb. 2, Takaoka (2000) (in Japanese).

Based on the peeling system newly developed for low-

grade small-diameter logs, production systems for laminated veneer lumber and veneer tray were introduced, together with the utilization of core bolts as exterior wood deck, fence, etc.

KAWAI, S.: **Wood based materials and life cycle analysis,** The Textbook of 2nd Seminar for the development of environmentally friendly wood based materials, March 27, Miyazaki (2000) (in Japanese).

The concepts of life cycle analysis and zero-emission process were introduced. The life cycle analysis of 3-stories timber building, timber bridge and recycled chip were reviewed.

KAWAI, S.: **New resources in regional forest—Utilization of forest residues and low-grade logs,** Landscape (Nihon Zouen Gakkaishi), **63**, 3, 193–195 (2000) (in Japanese).

Total utilization system of forest residues and low-grade logs in regional forest was proposed.

YANO, H.: **Ultimate strength of wood—High strength wood-based materials—,** Report of 6th Research Group of Jpn. Wood Research Society, II-2–12 (1999) (in Japanese).

Ultimate strength of wood was estimated based on the Young's modulus and volume ratio of cellulose crystal region and matrix substances. Production of high strength wood based materials by a combination of resin impregnation and compression was described.

YANO, H.: **Fundamental knowledge on wood science,** Text book of wood science seminar, Kansai branch, Wood technological association of Jpn. 1–15 (1999) (in Japanese).

Fundamental knowledges on wood structures and wood physics to use wood as a building materials were described.

YANO, H.: **Thermal softening behaviour of wood from room temperature to 100°C,** Proceedings of the symposium in 1999 of the study group of rheology, Jpn Wood Research Society, 32–37 (1999) (in Japanese).

Thermal softening behaviour of wood from room temperature to 100°C in oven-dry condition and water swollen condition was reviewed.

ASANO, N., J. NISHIMURA, K. NISHIMIYA, T. HATA, Y. IMAMURA, S. ISHIHARA and B. TOMITA: **Formaldehyde reduction in indoor environments by wood charcoals,** *Wood Research,* No. **86**, 7–8 (1999).

The effect of carbonization temperature of wood charcoal on the reduction ability of gaseous formaldehyde was studied for a basic study on air purification in indoor environments. The ability to remove formaldehyde was maximal when using wood charcoal carbonized at a temperature of 600°C, which was greatly influenced by the physical and chemical factors. The gas passed through the powder of carbonized wood charcoal was analyzed by GC-MS. The increase of H_2O was detected in gas from an outlet compared to that of the intake gas, suggesting the change of toxic gas to a harmless gas.

SU, W.-Y., SUBYAKTO, T. HATA, Y. IMAMURA and S. ISHIHARA: **Enhancement of fire retardancy of plywood by incorporation of boron or phosphate compounds in the glue,** New tropical timber crops: Challenges in processing and utilization, *Proceeding of the International Tropical Wood Conference,* 321–329 (1999).

Incombustibility of 3-ply plywoods bonded with urea melamine formaldehyde resin mixed with ammonium pentaborate or ammonium dihydrogen phosphate was evaluated according to JIS A 1322. The distributions of the chemicals in the plywoods were detected by X-ray photoelectron spectroscopy and scanning electron microscope. The specimens of plywood were manufactured using urea-melamine formaldehyde resin mixed with ammonium pentaborate (UMB), or dihydrogen phosphate (UMP). The addition ratios were adjusted to 2% to 4% and 6%, based on the molecular weight of boron or phosphorus. The properties of incombustibility were detected in terms of the glowing time and char length. The specimens treated with UMB performed more prominent reduction on glowing time. Similar tendency was observed on the reduction of char length in both UMB and UMP treated specimens. The improvement of fire retardant properties was increased in proportion to the treating amount in UMB treated specimens. The boron and phosphate compounds were assumed to be moved from the glue lines while pressing and captured in wood cells for providing fire retardant properties. The results obtained from XPS clearly showed that boron migrated from glue to wood elements, and similar tendency was observed for phosphorus. It suggested that there were possibilities for chemical treated specimens to have better fire retardancy in glue-additive treatment. The cross-sectional photos from SEM showed that untreated specimen formed honeycomb structure in the interface near glue line. However, the cell structure and cell wall thickness retained the intact conditions for longer period in the specimens treated with UMB or UMP. The influences of different thickness of the exposed surface layer were also observed. The specimens with thin surface layer gave shorter glowing time, but specimens with thicker surface overlaid resulted in shorter char length. The method of adding fire retardants in glue while plywood manufacture was proven to be a practical approach providing them the effective fire-retardant properties. This method would be easily introduced to commercial plants which engaged in plywood production.

HATA, T., D. MEIER, T. KAJIMOTO, T. OTONO and Y. IMAMURA: **Pyrolysis of CCA treated wood—Fate of arsenic,** *Proceedings of 43rd Meeting of Materials Study Group in Japan Science Council,* 163–164 (1999) (in Japanese).

Disposal of woods treated with CCA preservatives has become a serious problem not only in Japan but in other countries. Base components for houses, railway sleepers, timber from landscape, cable drums, telephone poles, and so on, generate such wood waste. After impregnating with CCA preservative the chemical compounds might be fixed to the cell walls of the wood matrix. Substantial amounts of CCA preservative remain in the wood for long years and environmentally benign disposal technologies are needed to be developed. Burning the wood waste,

which is one of the disposal ways, emits highly toxic smoke and fumes. There has been very little study on the emission of such smoke and fumes from burning CCA treated wood. The release of volatile compounds during heating of wood samples was studied in this experiment in order to investigate the effect of the supplied energy on the samples. Milled powder was prepared from CCA treated wood (*Tsuga heterophylla* Sarg). One mg of the powder was put in a flask and heated linearly from room temperature up to 400, 500, and 600°C. The reaction was stopped immediately after reaching the target temperature. Smoke and fumes were cooled by liquid nitrogen and the emitted gas went through tetra-n-butylammonium hydroxide (TBAH) for collection of arsenic. The yield of oil in the phase of solid, liquid and air were measured. The concentration of arsenic was measured by AAS and ICP. It was estimated that lower temperature and longer time of heating may result in higher concentration of arsenic in the oil.

KAJIMOTO, T., M. TAKAGAKI, T. HATA and Y. IMAMURA: **Separation of components of CCA treated wood by fast pyrolysis,** *Proceedings of 15th Annual Meeting of Association of Wood Preservation,* 43–47 (1999) (in Japanese).

The components CCA treated wood by fast pyrolysis were separated and tried to develop to energy resource or other useful applications. The chemical compounds caused by fast pyrolysis from CCA treated wood was discussed.

INOUE, S., T. HATA and Y. IMAMURA: **Components and anti-fungal efficiency of wood-vinegar-liquor prepared under different carbonization conditions,** *Proceedings of the 11th MRS-J Annual Meeting Session 1 "New Plant Materials" (Kawasaki-shi),* p. 34–37 (1999) (in Japanese with English summary).

The wood-vinegar-liquor (WVL) obtained by wood carbonization process is widely used in many applications today, however, the composition of WVL is easily changed due to the types of raw materials and carbonization conditions. In this study, the effect of carbonizing temperatures and heating rates on the chemical composition of Sugi *(Cryptomeria japonica)* WVL was evaluated. In addition, the effectiveness of WVL in controlling wood-destroying fungi and termites was examined. The GCMS analysis showed that the maximum yield of WVL was obtained between 300°C–400°C of carbonization temperatures, and phenolic components which contributed on biological control increased around these temperatures. The proportion of cresol increased under the carbonization temperatures above 500°C. Biological testing using wood destroying fungi of *Fomitopsis palustris* and *Trametes versicolor* showed also that the yield of anti-fungal components increased with the increase of the carbonization temperatures and heating rates.

NISHIMIYA, K., T. HATA, Y. IMAMURA and H. KIKUCHI: **Development of wood-metal composites by new powder sintering method,** *Proceedings of the 11th MRS-J Annual Meeting Session 1 "New Plant Materials" (Kawasaki-shi),* p. 42–45 (1999) (in Japanese with English Summary)

Wood-metal composite (WMC) was developed from wood charcoal by new powder sintering method. Electrical and thermal properties of the composite with sintered charcoal and metal were measured. The graphitization of the sintered charcoal affected those properties. The electric resistivity of WMC was lower with higher heat treatment temperature (HTT). This result was almost the same as that of blank (sintering charcoal without metals). The electric resistivity of WMC with aluminum was decreased more with higher aluminum concentration. These results showed that the concentration of metals is able to control the electric resistivity of WMC. Thermal conductivity of WMC showed similar trend with electric resistivity. The higher concentration of aluminum, the higher the thermal conductivity of WMC. Different kinds of metals led to different trend in these properties. Strong diffraction peak was observed for higher HTT by X-ray diffraction analysis. The graphitization developed with higher HTT. Diffraction peak was observed with higher concentration of metals even though no peak was appeared at the same HTT in lower metal concentration. In this case, the graphitization in WMC occurred at lower HTT. It was induced from these results that the graphitization of WMC was promoted with the catalytic action of the metals.

HATA, T., Y. IMAMURA, E. KOBAYASHI, K. YAMANE and H. KIKUCHI: **Microstructural investigation of wood-based carbon materials by electron microscopy,** *Proceedings of the Third International Workshop on Materials Science,* Hanoi, November 2–4, 345–348 (1999)

Wood was carbonized at 700°C, then the carbonized wood was graphitized using the novel consolidation method in order to develop wood composite products with new functions. The wood charcoal and the graphitization was observed by Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). Sugi (*Cryptomeria japonica* D. Don), a fast growing tree species in Japan, was carbonized up to 700°C at a heating rate of 10°C/min using a laboratory-scale electric-furnace. After the target temperature was attained, the temperature was kept constant for 30 min and then allowed to cool naturally. Based on a new powder consolidation method, electric pulse was directly applied to the wood charcoal. The wood charcoal powder was then fixed into the mold made of carbon and pressed. Different kinds and sizes of graphitic particles showing the spherical graphitic particles in wood carbonized at 700°C for 30 min were observed using high-resolution electron microscopy. The spherical shapes exhibited concentric fringe or onion-like images. Examinations of the specimens tilted at 10 degrees proved that they are nearly spherical. The diameters of small particles were between 65–240 Å. The diameter of the innermost layer of the spherical particles could be measured at 10 Å. Polygonization was a typical morphological feature of graphitized carbon. Concentric fringe images were not perfectly nor clearly observed in adjacent particles. The sizes of the particles were not uniform and the distances between graphitic fringes were 5–6 Å, larger than that of graphite, 3.4 Å. The carbonized microfibrillar structure was aligned in parallel to

each other. The microstructures between microfibrils and the adjacent areas including onion-like graphitic carbons were observed to be quite different microstructure. Graphitic particles were growing in the region close to the carbonized microfibril. It was assumed that the random microstructure of the microfibril co-existed with the graphitic particles. The Bragg angle of the wood charcoal sintered with the new powder consolidation method which was analyzed by X-ray diffraction was almost close to that of graphite at heat treatment temperature of 1,770°C. The graphitization of wood charcoal was confirmed by transmission electron microscopy. The layer spacing in the wood charcoal sintered at 1,700°C for 5 min was almost the same as that of the wood charcoal carbonized at 2,300°C for 3 hrs. Results of experiments on the development of wood ceramics were also presented.

HATA, T., Y. IMAMURA, E. KOBAYASHI, K. YAMANE and H. KIKUCHI: **Microstructural investigation of bio-carbon from wood,** *International Symposium, Can biological production harmonize with environment?,* Tokyo, October 19–20, 99–100 (1999).

Japanese cedar (*Cryptomeria japonica* D. Don) was carbonized or graphitized for the development of new type of wood composite products. Onion-like graphitic particles and graphitization in wood charcoal were observed by scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The specimen was carbonized by heat treatment at increases of 10°C/min from room temperature up to 700°C. Direct pulse sintering method applied to the wood charcoal, to which pulse of eclectic current was directly applied. Different kinds and sizes of onion-like graphitic particles in carbonized wood were observed using electron microscopy. The graphitization of wood charcoal was observed by TEM.

MURASE, K., T. HATA, H. YANO and Y. IMAMURA: **Changes to the permeability of wood resulting from carbonization,** *Wood Research,* No. **86**, 49–50 (1999).

The development of micropores during carbonization is one of the most important features characterizing the physical properties of charcoal. Such structural changes might be expected to improve the permeability of wood and enhance the penetration of liquid, especially for less permeable and less penetrable woods, such as Japanese larch. In this study, changes in air permeability and water penetrability due to carbonization were investigated in conjunction with scanning electron microscope (SEM) observations of microstructure.

HATA, T.: **Clean-up environment with charcoal,** Forest-Woods and Environment, *Open Seminar of Kyoto University,* 33–40 (1998) (in Japanese).

The property of wood charcoal from the point of the material for clean-up environment was plainly explained to general people.

HATA, T.: **Micro structural analysis of bio carbon from wood,** *Cellulose Communications,* **6**(3), 127–133 (1999) (in Japanese).

Sugi *(Cryptomeria japonica)* was carbonized at 700°C, using a laboratory-scale electric furnace. Then the carbonized wood was graphitized using the novel consolidation method, in which electric pulse was directly applied to the wood charcoal, in order to develop wood composite products with new functions. The wood charcoal and the graphitization was observed by Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). Different kinds and sizes of graphitic particles showing the spherical graphitic particles in wood carbonized at 700°C for 30 min were observed using high-resolution electron microscopy. The spherical shapes exhibited concentric fringe or onion-like images. The microstructures between microfibrils and the adjacent areas including onion-like graphitic carbons were observed to be quite different microstructure. It was assumed that the random microstructure of the microfibril co-existed with the graphitic particles. The Bragg angle of the wood charcoal sintered with the new powder consolidation method which was analyzed by X-ray diffraction was almost close to that of graphite at heat treatment temperature of 1,770°C. The graphitization of wood charcoal was confirmed by transmission electron microscopy.

HATA, T., Y. IMAMURA, E. KOBAYASHI, T. YAMANE and K. KIKUCHI: **Onion-like graphitic particles observed in wood charcoal,** *J. Wood Science,* **46**, 89–92 (2000).

This report describes the growth of onion-like graphitic particles during evolution in wood charcoal. The microstructure of carbonized microfibrils, which were observed in regions close to the groups of onion-like graphitic particles, were also presented.

HATA, T., L. P. NOVICIO and Y. IMAMURA: **Ultra-structural change of wood under thermal conversion,** *New Horizons in Wood Anatomy,* 330–333 (2000).

Sugi (*Cryptomeria japonica* D. Don) was heated increasing the temperature at 4–50°C/min up to 1,300°C. Morphological change in cross section and microstructure during carbonization were examined by environmental scanning electron microscope. The charcoal carbonized at 600°C showed a little shrinkage by elevating ambient temperature from a room temperature till 1,300°C. On the other hand, original wood showed drastic change in the cell shapes over 450°C during carbonization. The wood was carbonized at 700°C and then sintered at about 2,500°C. The transmission electron microscope observations revealed that the microstructure of wood carbonized at 700°C showed onion like hollow graphitic structures. After sintered at 2,500°C, the graphitic structure of the sintered specimen was observed, in order of frequency, in the amorphous region, the randomly oriented region, and the oriented region. The plane of the graphite was observed where the plane distance was 3.41 Å, close to the 3.354 Å of graphite.

HATA, T.: **Production and property of reconstituted wood,** Experimental Manual of Wood Science, Bunneido Shuppan (Tokyo), 214–214 (2000) (in Japanese).

The production method and property of reconstituted wood such as PSL and SST are plainly explained for university students.

IMAMURA, Y. : **Development of new functional carbon materials from wood charcoal,** *J. Catalysis Soc. Jpn.*, **41**(4), 254–258 (1999) (in Japanese with English summary).

The removal of the heavy metals from the polluted water and purification of NOx in the air was conducted by using the carbonizing wood materials, and it was evaluated that their efficiency changes depending on the heating temperatures. The process of graphitization of sintered wood charcoal was discussed in relating with the electric conductivity and the ultrastructural characteristics.

IMAMURA, Y. : **Traditional advanced material of wood charcoal harmonized with environment,** *Urban Green Tech.*, No. **35**, 26–29 (1999) (in Japanese with English summary).

Wood charcoal is a material which prevents the global warming by fixing carbon dioxide as solid carbon, and has attracting the much attention as environmental clean-up and new functional materials. The removal of the heavy metals from the polluted water, and purification or detoxification of the volatile organic compound- and NOx-contamined air were conducted by using the carbonize wood materials. The removal ability was strongly affected by the carbonization temperatures, and the high removal capacity ranged from 600 to 1,000°C. The formation of a graphite structure in the carbonized and sintered wood is directly shown by electron microscopic observations, and these ultrastructural characteristics are discussed with the new functions of the wood-based carbon materials such as electric resistivity.

TSUNODA, K., T. YOSHIMURA, H. MATSUOKA and Y. HIKAWA : **A method to evaluate the effectiveness of bait application using a transferred nest of *Coptotermes formosanus* Shiraki (Isoptera : Rhinotermitidae),** *The Int. Res. Group on Wood Preserv. Document*, No. IRG/WP 99-20161 (1999).

Although a survey of monitoring stations can tell us the decline of termite activity after application of baits, it seems questionable to conclude an eradication of a whole colony of subterranean termites if the termites move out their foraging territory. Only reliable method to ensure the success of bait application is to determine the absence of live termites in their nest in accordance with a survey of monitoring stations. A nest of *Coptotermes formosanus* was first collected from the field and buried back into the soil with some wooden blocks in a test site. Monitoring stations were installed around the nest to examine termite activity. After termites recovered their activity, mark-release-recapture was applied to estimate foraging population and then bait application was initiated. When foraging activity ceased, the nest was dug out to find any live termites present. This technique allowed us to draw out a conclusion that baiting eliminated a whole colony of *C. formosanus*.

TSUNODA, K. and H. KUMAGAI : **How sapstain affects utilisation options in Japan,** *Proc. 2nd New Zealand Sapstain Symposium, Forest Research Bulletin 215*, Rotorua, New Zealand, Nov. 18–19, 61–63 (1999).

This paper is concerned with sapstain problems and usage limitation of stained products in Japan. Wood demand for lumber, plywood, chips, pulp and others in Japan is approximately 110,000,000 m^3 per year, and wood supply heavily depends on imports (approximately 80%). Lumber production accounts for approximately 50,000,000 m^3 per year with a self-supporting proportion of 32–33%. The market for anti-sapstain products is not big in Japan and it has been estimated at US$ 10 million annually. Sawmills are very determined to control microbial growth on lumber produced especially from imported logs. Users generally show some reluctance in purchasing infected sawn products or logs due to their cosmetic disadvantage even when lower prices are given to them. For low-grade uses such as package materials and pallets, mould infection can be more serious than sapstain. In contrast, sapstain becomes a serious problem for high-quality uses such as furniture and interior finishing. Therefore, highly susceptible timbers must be properly treated to prevent microbial growth during storage and transport into export markets, and retreatment is required at the sawmills just after they are sawn for Japanese markets.

TSUNODA, K. : **Application of borates to wood preservation (2) Field evaluation and applicability to the preservative treatment of composites,** *Mokuzai Hozon (Wood Preservation)*, **25**, 251–262 (1999) (in Japanese).

This review covers field evaluation of borates against subterranean termites in Australia, USA and Japan as wood preservatives to protect wood under unexposed, above-ground conditions. Although results are varied with test methods and test sites, *Timbor*-treated lumber was proved to be resistant against *Coptotermes formosanus* at retentions of 1.2–2.2% boric acid equivalent in Kagoshima and Hawaii. Applicability of zinc borate to the preservative treatment of composites has been strongly supported in both laboratory and field trials.

TSUNODA, K. : **Gaseous treatment with allyl isothiocyanate to control established microbial infestation on wood,** *J. Wood Sci.*, **46**(2), 154–158 (2000).

Applicability of gaseous treatment with allyl isothiocyanate (AIT) was evaluated for controlling the established microbial infestation on wood in the laboratory. Small sapwood specimens of 5 wood species measuring 20 mm (T) × 20 mm (R) × 10 mm (L) were first preincubated on 2% malt-agar medium with placing them on a fully grown monoculture of 7 test fungi. After 7 weeks preincubation they were transferred onto the fresh medium and exposed to AIT fumigant at concentrations of 2,360 and 23,600 ppm AIT in the air of a petri dish to determine threshold values of exposure periods for each test fungus. A concentration of 2,360 ppm was not effective to *Penicillium funiculosum*, *Gliocladium virens* and *Rhizopus stolonifer* in any case of wood species-exposure period combinations. Those test fungi could grow even at 23,600 ppm after 48 hrs exposure when *Cryptomeria japonica* and *Fagus crenata* were used as wood substrate. Growth of other test fungi was inhibited at 2,360 ppm with a few exceptions in the case of *Aspergillus niger*. The required periods of exposure to suppress microbial regrowth were different with wood species-test fungi combinations. As

two wood-decaying basidiomycetes, *Trametes versicolor* and *Fomitopsis palustris* were easily controlled at 2,360 ppm after 24 hrs exposure regardless of wood species, AIT treatment proved to be applicable to the control of internal decay of utility poles and other relevant products in service.

TSUNODA, K., Y. HIKAWA and T. YOSHIMURA : **Efficacy of hexaflumuron as a bait-toxicant in the field using a transferred nest of *Coptotermes formosanvs* Shiraki (Isoptera : Rhinotermitidae),** *The Int. Res. Group on Wood Preserv. Document,* No. IRG/WP 00-10379 (2000).

A natural nest of *Coptotermes formosanus* Shiraki was transferred into the field test site, and monitoring stations were installed around the nest buried back in the ground in January, 1995. Following estimation of foraging populations [271,200±49,600 (July–October, 1996); 142,600±19,600 (April–July, 1998)], bait applications were conducted twice. Termites came back to the stations in spring, 1998, although termites were not present at any monitoring station at the end of the first application (November, 1996–December, 1997). Second baitings started from October, 1998 and ended in July, 1999 when no termites were found at the stations. The nest was then recovered, and careful examination clearly demonstrated that the colony was completely eradicated after 419 mg hexaflumuron was consumed by colony members.

TSUNODA, K., A. ADACHI, T. YOSHIMURA, T. BYRNE, P. I. MORRIS, and J. K. GRACE : **Resistance of borate-treated lumber to subterranean termites under protected, above-ground conditions,** *The Int. Res. Group on Wood Preserv. Document,* No. IRG/WP 00-30239 (2000).

An experiment to simulate the dodai (sill plate) of the Japanese houses was conducted at the termite field test site of Wood Research Institute in Kagoshima, Japan where two economically important subterranean termite species [*Coptotermes formosanus Shiraki and Reticulitermes speratus* (Kolbe)] are established. DOT (disodium octaborate tetrahydrate)-treated hem-fir samples [Tsuga heterophylla (Raf.) Sarg. and Abies amabilis (Dougl.) Forbes] in a dimension of 105×105×400 mm were placed on concrete blocks 19 cm above ground surface. The test samples were prepared from sound wood samples pressure treated to supply 10 replicates of shell-treated materials at target levels of 2% BAE and 3% BAE. The subsequent diffusion storage produced another set of through-treated samples at the same target levels. Feeder stakes within the block hollows extended into the soil to facilitate the access of the termites to the wood samples. The assembled sets were covered with plastic boxes to protect the samples from the weather. Samples were visually inspected for termite attack and decay and rated according to AWPA standards. After 4 years' exposure, borate-treated samples (2% BAE shell, 3% BAE shell, 2% BAE through and 3% BAE through treatments) were free from termite attack, while one replicate each of 2% BAE with DDAC (didecyldimethylammonium chloride) and CCA 4.0 kg/m^3 treatments, the latter included as a reference preservative, were slightly attacked. Untreated hem-fir and hinoki (*Chamaecyparis obtusa* Endl.) controls were slightly to heavily attacked during the same test period. No sign of decay was found on any sample, although moisture contents were well above fiber saturation points in some samples.

YOSHIMURA, T.: **The 1999 Spring meeting of the working group on biodeterioration,** *Mokuzai Hozon (Wood Preservation),* **25**(3), 34–37 (1999) (in Japanese).

The 1999 Spring Meeting of the Working Group on Biodeterioration in the Japan Wood Research Society was held on April 4th, 1999. The subject of the meeting was "Durability and Amenity of Houses". Following the three presentations, a fruitful discussion was made under the supervision by Prof. Kajita of Kyoto Prefectural University. In this review, the presentations and the discussion were abstracted.

KUMAGAI, H. and K. TSUNODA : **Present status of anti-sapstain treatment in Japan,** *Mokuzai Hozon (Wood Preservation),* **26**, 30–33 (2000) (in Japanese).

This paper is concerned with the present status of anti-sapstain treatment in Japan and briefly refers to the following subjects : predominant fungal species in relation to timber species, treatment methods, materials of treatment tanks, treatment time, treatment concentrations, and damage caused by microbial infection.

YALINKILIC, M. K., E. D. GEZER, M. TAKAHASHI, Z. DEMIRCI, R. IIHAN and Y. IMAMURA : **Boron addition to non- or low-formaldehyde cross-linking reagents to enhance biological resistance and dimensional stability of wood,** *Holz als Roh- und Werkstoff,* **57**(5), 351–367 (1999).

Boric acid (BA) and phenylboronic acid (PBA) were added into aqueous solutions of non- or low-formaldehyde reagents; dimethylol dihidroxy ethyleneurea (DMDHEU), glutaraldehyde (GA) and glyoxal (GX), in order benefit from their potential synergistic effects in wood. Boron addition to GA improved the anti-swelling efficiency (ASE) of wood while other combinations resulted in some decreases. Ion chromatography analysis of boron leaching supported the presumption on boron-GX complexion referred to ASE changes in the presence of boron. Although such complexations seemed to reduce boron leaching, boron appeared to decrease cross-linking efficacy of GX and to a lesser degree of DMDHEU to the wood cell wall which was understood from declining ASE of wood after boron addition. Boron addition to these reagents considerably improved the decay resistance against Tyromyces palustris and Coriolus versicolor, which are the representative test fungi of brown- and white-rot in Japanese Industrial Standard (JIS) A-9201-1991, respectively. PBA had somewhat less contribution to decay resistance of GX most possibly due to chemical complexation. GA proved superior in decay resistance to the other two reagents. Mass loss due to the Formosan termite Coptotermes formosanus attack could be reduced to a minimum with total inactivation of termites by PBA addition. BA retention did not suffice to impart complete termite resistance after ten cycles of severe weathering of the specimens. Thus, BA found appropriate to be added to the used cross-linking agents in such service conditions where decay risk is high while PBA combinations should be preferred if termite damage prevails.

YALINKILIC, M. K., Y. IMAMURA, M. TAKAHASHI, A. C. YALINKLIC and Z. DEMIRCI: **FTIR studies of the effects of outdoor exposure on vanish-coated wood pretreated with CCB or water repellents,** *J. Coating Technol.,* **71**(Aug), 103–112 (1999).

Scots pine (*Pinus sylvestris* L.) and chestnut (*Castanea sative* Mill.) panels were coated with a polyurethane or an alkyd-based synthetic varnish. Some of the panels were impregnated with chromium-copper-boron (CCB) or the varnishes themselves before coating, as preservative-coating or water repellent (WR)-coating combination treatments, respectively. Earlier drastic changes in the intensity of the bands assigned to lignin and their shifts to some other stretching points were mostly attributed to chemical modification of lignin with the chromium in CCB, as well as the previously reported high color stability of CCB-impregnated wood. IR spectra of the nine months of weathering indicated that the synthetic varnish coating of non-impregnated or CCB-impregnated wood limited the reactions in lignin compared with polyurethane coating. Wood density and structural difference also seemed to play an important role since changes in lignin were mostly observed after six months of exposure for chestnut wood. Therefore, chemical reactions of CCB-wood cell wall components on the surface appeared likely to be affected from varnish types (their relative absorbency and distribution of sunlight), wood species (density and extractive substances), and exposure time and conditions.

SUDIYANI, Y., M. TAKAHASHI, Y. IMAMURA and K. MINATO: **Physical and biological properties of chemically modified wood before and after weathering,** *Wood Research,* No. **86**, 1–6 (1999).

Physical and biological properties of several chemically modified woods were investigated before and after weathering. Thin wood blocks, prepared from sapwood of albizzia (*Paraserianthes falcata* Becker.) and sugi (*Cryptomeria japonica* D. Don), were treated with acetic anhydride, propylene oxide, dimethylol dihydroxy ethylene urea (DMDHEU), and low molecular weight phenol formaldehyde resin (PF-resin). Outdoor (natural) exposure was made for 1 year, and accelerated (artificial) weathering was conducted for 1,080 hours in weather-meter, by irradiation of ultraviolet ray and water flashing. Weathering with the presence of water promoted the deterioration of wood under ultraviolet ray irradiation. From the results of color change, surface failure and weight loss of weathered specimens, acetylation and PF-resin treatments were ranked higher in protecting wood than propylene oxide and DMDHEU treatments. Enhancement of decay resistance and persistence against weathering were recognized in all treatments. The acetylation and PF-resin treatments were again better. Fast-growing and low-density albizzia may be promising for use outdoors following acetylation or PF-resin treatment.

SUDIYANI, Y., S. TSUJIYAMA, Y. IMAMURA, M. TAKAHASHI, K. MINATO and H. KAJITA: **Chemical characteristics of surfaces of hardwood and softwood deteriorated by weathering,** *J. Wood Sci.,* **45**(4), 348–353 (1999).

The factors that cause weather-induced deterioration of wood surfaces were determined by chemical and spectroscopic analyses. Albizzia (*Paraserianthes falcata* Becker.) and sugi (*Cryptomeria japonica* D. Don) were exposed to two temperate conditions of natural weathering with and without rainfall and to accelerated conditions of artificial weathering coupled with ultraviolet (UV) light irradiation and water flashing. Infrared spectroscopic analysis showed that the oxidative reaction of lignin was observed under all conditions of weathering for both wood species. However, a marked decrease in lignin and hemicellulose content were recognized when albizzia woods were exposed to weathering with water. Lignin content in the softwood sugi did not decrease as much as in albizzia even in the presence of water, but the modification of lignin macromolecules was assumed to be accelerated by water, as seen by electron spin resonance spectroscopy. These results showed that the presence of water promotes the weathering deterioration of wood under UV irradiation.

YANASE, Y., Y. FUJII, S. OKUMURA, Y. IMAMURA and M. KOZAKI: **Detection of termite attack in wooden buildings using AE monitoring: A case study at a house of wooden panel construction,** *Jpn. J. Environ. Entomol. Zool.,* **10**(4), 160–168 (1999) (in Japanese with English summary).

Acoustic emission (AE) monitoring for the non-destructive detection of termite attack in wood was applied to a house of wooden panel construction attacked by Coptotermes formosanus Shiraki. AE monitoring was applied to the floor- or the wall-panel around the bathroom and the entrance porch. AE sensors with resonant frequency of 150 kHz were attached directly to the surface of floor joints, which were the construction members of floor flame and were made of dimension lumbers whose cross section was 37 mm by 87 mm in square. For the measurement of AEs generated in the studs of the wall panel, the AE sensor was attached using a needle-type sensor holder, which plays a role of a waveguide penetrating through the wall covering made of plaster board and wall paper. Significant numbers more than 10 of AEs were detected from the floor- and the wall-panels around the bathroom and entrance porch. By boring and disassembling near the AE detection points apart, galleries or termites were found and the positions where significant number of AEs were detected almost corresponded to the positions where termites were attacking.

YANASE, Y., Y. FUJII, S. OKUMURA, Y. IMAMURA and T. YOSHIMURA: **Detection of acoustic emission (AE) generated by termite attack in a wooden house,** *Proceedings of Int. Con. on Effective Utilization of Plantation Timber,* 530–537 (1999).

Recently, considerable attention has been paid to method for termite control, which involves few or no chemicals. To reduce the amount of termiticide needed, it is necessary to detect termite attack in the wood as early as possible. The feasibility of acoustic emission (AE) monitoring for the nondestructive detection of termite attack has been discussed previously. In this study, we propose some technical solutions for the application of AE

monitoring to practical control operations. Using a needle-type sensor holder combined with an AE sensor (PZT sensor), AEs generated and propagated within floors and walls could be detected effectively. A 0.04 mm-thick sample of the piezoelectric polymer PVDF, which was inserted between the construction members of wooden housed, could detect AEs propagated both in such members and at joint surfaces, although PVDF film is less sensitive than a PZT sensor. The feasibility of using a portable AE detector as the input device for a total security system against termite attack in a house is also discussed.

YANASE, Y., Y. FUJII, S. OKUMURA, T. YOSHIMURA and Y. IMAMURA: **Development of AE sensor using PVDF film for detecting termite attack : Application of PVDF film inserted between construction members of wooden house,** *J. Soc. Mat. Sci.*, **49**(4), 401–405 (2000) (in Japanese with English summary).

Termite bites and chews the wood and this causes microfractures in the wood. The authors have detected the acoustic emission (AE) generated by the microfractures and confirmed the feasibility of AE monitoring as a non-destructive inspection method to detect termite attack in wooden houses. In this study, the feasibility of piezoelectric polymer, PVDF (polyvinylidene fluoride) as an AE sensor was investigated. Flexible PVDF film of 40 μm inserted between the jointing surfaces of wooden posts of 105 mm by 45 mm in square could detect the artificial AEs generated by the breaking of pencil lead and the AEs generated by termite attack. AE amplitude increased in accordance with the pressure applied to posts up to about 1 Mpa. Due to the anisotropy of the AE attenuation in the wood, the monitoring area of a PVDF film inserted between the end-end surfaces of the posts was larger the film between the end-side surfaces. The higher AE amplitude was obtained by sandwiching the PVDF film by a pair of elastic Teflon sheet of 0.5 mm thick to get an intimate contact among the film and the posts. The sensitivity of the one of the three-layered PVDF film about two times larger than the PVDF film of 40 μm.

YANASE, Y., M. SHIBATA, Y. FUJII, S. OKUMURA, K. IWAMOTO, T. NOGIWA, T. YOSHIMURA and Y. IMAMURA: **Feasibility of termite control using crushed cement-stabilized sludge (Polynite) as a physical barrier and acoustic emission (AE) monitoring,** *The Int. Group on Wood Preserv. Document,* No. IRG/WP 00-10381 (2000).

For control of the subterranean termite, particles of crushed cement-stabilized sludge (Polynite) were applied as a physical barrier layer, and acoustic emission (AE) monitoring as a non-destructive detection of termite attack in the Polynite was examined. Penetrating of termites of Coptotermes formosanus Shiraki into a physical barrier layer with particles of Polynite was investigated in the laboratory. Layer with particles of Polynite from 1.70 to 2.00 mm in diameter could prevent *C. formosanus* from penetrating. The layers of smaller particles were tunneled by *C. formosanus* and the layers of larger sizes were passed through. When the layer of Polynite was tunneled and passed through by *C. formosanus*, AEs were detected by AE sensor with waveguide penetrated into the layer of Polynite. In order to realize an effective detection of penetrating of termites into physical barrier, AE detecting method using a sensor of PVDF film was also discussed.

FUJII, Y., Y. KOMATSU, Y. YANASE, S. OKUMURA, Y. IMAMURA, M. TARUI, H. TAKIUCHI and A. INAI: **New approaches to practical evaluation method of biodegradation of wooden construction Nondestructive detection of defects using radar technique,** *The Int. Group on Wood Preserv. Document,* No. IRG/WP 00-20214 (2000).

To establish a comprehensive and practical method to evaluate bio-degradation of wooden constructions, scanning using portable radar equipment was applied to detect decay, holes and other inner defects of wooden constructions non-destructively. The feasibility of the technique was compared with the drilling resistance measurement, the distribution of water content and specific gravity, and the sight inspection method. The distribution the abnormal reflection of electromagnetic waves could be associated with the area of higher water content, holes or decayed area. The reflected wave was analyzed not only in the time domain but also in the frequency domain, to distinguish the area of bio-degradation from sound area. AE monitoring to detect termite attack was also carried out. A practical method using portable measuring apparatus and tools to assess the biodegradation of wooden constructions was proposed, involving the radar technique, the measurement of drilling resistance, water content, attenuation and reflection of sound and elastic waves and some other techniques.

MINATO, K., T. TAKEMOTO and T. YOSHIMURA: **Contribution of extractives to fungal and termite resistance of Brazilian wood *Bagassa guianensis* Aubl.,** *Mokuzai Hozon (Wood Preservation),* **25**(4), 13–20 (1999) (in Japanese with English summary).

The heartwood of *Bagassa guianensis* Aubl., which grows in South America, is empirically known to be durable against fungi and insects decay. In this study, we evaluated the fungal and termite resistance of *B. guianensis wood,* and conducted the separation of substances having the antifungal and antitermite properties. As the results, *B. guianensis* wood has excellent durability against both fungi (*Trametes versicolor* (L.: Fr.) Pilat and *Formitopsis palustris* (Berk. Et Curt.) Murr.) and a termite (*Coptotermes formosanus* Shiraki). The antifungal components were found in both chloroform and methanol extracts, while most of the strong antitermite activity was observed in the methanol extracts. The methanol extracts were subjected to two-dimensional thin layer chromatography (TLC) on a cellulose plate and were examined for their effects on feeding behavior of termites by a choice test. Some substances having high polarity on a cellulose TLC were found in the portion where was not attacked by termites. The method using a cellulose TLC described here appears to be applicable for separation of antitermite substances from the crude extracts.

KAWASE, T., K. TANBA, X. PENG, T. FUJII, H. SAWADA, Y. IKEMATSU, T. YOSHIMURA and K. WADA: **Water repellent and antibacterial modification of cellulose using fluoroalkyl end-capped oligomers,** *Sen'i*

Gakkaishi, **56**(3), 155–162 (2000) (in Japanese with English summary).

Surface modification of cellulose to give an antibacterial property as well as water- and oil-repellency was studied using fluoroalkyl end-capped oligomeric allylammonium hydrochloride, allylammonium hudrochloride-fluorosilane combined system, and fluorosilanes having tributylphosphonium segments.

(1) In the case of modification with oligomeric allylammonium hydrochloride alone, oil-repellency increased in spite of low water-repellency. After immersion in water for 1h, modification effects were missing, which indicated the low water-durability of modification. (2) By combining allylammonium hydrochloride oligomers and fluorosilanes, modified cellulose surface exhibited high water- and oil-repellency. Modification effects were maintained even after immersion in water for 24h. Based on the ESCA analysis, it is suggested that allylammonium hydrochloride oligomers would be kept in the siloxane network on the cellulose surface. (3) Modification with fluorosilanes having tributylphosphonium segments could also change cellulose surface to highly water- and oil-repellent. Modified surface showed good microbioatasisactively against *Staphylococcus aureus*.

GRACE, J. K., R. I. OSHIRO, T. BYRNE, P. I. MORRIS and K. TSUNODA: **Termite resistance of borate-treated lumber in a three-year above-ground field test in Hawaii,** *The Int. Res. Group on Wood Preserv. Decument*, No. IRG/WP 00-30236 (2000).

A protected above-ground field test simulating the sill plate (dodai) used in conventional Japanese housing constructions was establish in both Hawaii and Japan to examine the efficacy of disodium octaborate tetrahydrate (DOT, 2% and 3% shell and through) wood treatments. In Hawaii, chromated copper arsenate (CCA, 4 kg/m^3) and ammoniacal copper zinc arsenate (ACZA, 4 kg/m^3) were included in the test, along with untreated western hemlock and Pacific silver fir controls. Both field sites support active Formosan subterranean termites, Coptotermes formosanus Shiraki, although termite pressure is greater in Hawaii probably due to the uniformly favorable environmental conditions. After three years, minor damage (visual rating of 7 in AWPA rating system) has been noted to four individual treatment dodai (out of a total of 10 boards per treatment) as follows: 2% BAE (Boric Acid Equivalent) shell treatment (1 board), 2% BAE+DDAC through treatment (2 boards) and CCA treatment (1 board). These same individual boards had been also rated in the second year of the study; and, although at Year 3 termites are still present on the boards in each case, there has been no further visible deterioration. This supports a hypothesis of delayed deterrence from termite exposure to these non-repellent treatments. In contrast, untreated control boards in Hawaii were completely destroyed within one to two years. Overall, all treatments have provided very good protection from termite attack over the three years of the study, with 9.3 representing the lowest mean rating. These results support the use of DOT, CCA or ACZA treatments to protect dodai from termite attack.

GREEN III, F. and T. YOSHIMURA: **Inhibition of termite damage by *N'N*-napthaloylhydroxyamine (NHA): *Reticulitermes flavipes* (Kollar) vs. *Coptotermes formosanus* Shiraki,** *The Int. Res. Group on Wood Preserv. Decument*, No. IRG/WP 00-10354 (2000).

The calcium precipitating agent NHA has been shown to protect southern yellow pine (SYP) from wood decay and termite damage comparible to CCA in field tests (Gulfport, MS) for two years (IRG/WP 99-30204). In a collaborative study, southern yellow pine wood blocks were vacuum treated with three concentrations of aqueous NHA and exposed in a no-choice test to Eastern subterranean termites (FPL, USA) and Formosan termites (WRI, Japan) to determine protection against termite damage. Individual blocks (leached and unleached) were exposed to *R. flavipes* (AWPA) or *C. formosanus* (JWPA) for 3–4 weeks. Mean weight loss of wood blocks after termite exposure ranged from 0.0 to 18.0% for *R. flavipes* and 6.0 to 20% for *C. formosanus*. Wood blocks exposed to *R. flavipes* were completely protected by 0.5 and 1.0% NHA, but weight loss in similar blocks challenged by *C. formosanus* were 6.0% and 6.2% respectively at the same concentrations. NHA acted as an effective termiticide for *R. flavipes* with 100% mortality after 3 weeks, but only soldiers were preferentially killed in *C. formosanus*. Formosan termite workers showed enhanced resistance to NHA treatment when compared to Eastern subterranean termites.

SASAKI, T., A. KOIZUMI, J. JENSEN, Y. IIJIMA, Y. TAMURA and K. KOMATSU: **End joint with glued-in hardwood dowels in timber construction I. Bending properties of beams jointed with single row of dowels,** *Mokuzai Gakkaishi*, **45**(1), 17–24, (1999) (in Japanese).

The application of glued-in hardwood dowels to end-jointing of beams was considered. This paper discusses development of theoretical expressions to calculate bending strength and stiffness and the results of bending tests for glulam beams jointed with a single row of dowels on the tension side. The modulus of rupture (MOR) and bending deflection of a beam was calculated using the combined theories of the pullout strength of hardwood-dowel joints based on the Volkersen model for single-lap joint, and the design method for reinforced concrete (RC) beams. It was assumed in the calculations that the dowel's withdrawal strength governs the bending failure of the beam. Test beams of various cross-sections were made of sugi *(Cryptomeria japonica)* and were end-jointed using 8 mm, or 12 mm diameter dowels *(Acer mono)* with polyurethane adhesive. The beams were tested in a four-point bending test set-up in which the joints were subjected to a pure moment. Experimental and calculated values of the MOR and the deflection for beams were compared.

The calculated MOR agreed well with the experimental values regardless of the dowel diameter or the height of the glulam members. The theoretical deflection at mid-span considering additional deflection caused by the pullout displacement of dowels also agreed well with the experimental results. The test results show that bending stiffness and strength of beams end-jointed with a single row of glued-in hardwood dowels can be predicted using the above mentioned theories.

KOIZUMI, A., J. JENSEN, T. SASAKI, Y. IIJIMA, Y. MATSUI and K. KOMATSU: **Withdrawal properties of hardwood dowels glued perpendicular to the grain,** *Mokuzai Gakkaishi,* **45**(3), 230–236, (1999) (in Japanese).

Withdrawal strength and stiffness of hardwood dowels glued perpendicular to the wood grain were studied. A theory assuming stress conditions based on the Volkersen model and failure governed by the maximum shear stress in the bond line was applied to predict pull-out strength and stiffness. A series of pull-out tests was conducted to study the effects of the cure times of adhesives, diameters of dowels, and number of dowels on the withdrawal properties. Materials used for dowels, wood members, and adhesives were hard maple (Acer saccharum), sugi (Cryptomeria japonica), and polyurethane adhesives. Two bond-line parameters: shear strength f_v and shear stiffness Γ, were determined by curve-fitting the theoretical expression to results of pull-out tests of 8-mm dowels with various embedded lengths. Dowel-failed results were included in the above-mentioned curve-fit because the maximum shear stresses in bond lines were considered to reach shear strength of dowels for those cases. As a result, f_v and Γ were determined as 7.8 MPa and 10.5 N/mm^3, which are similar to those determined for dowels glued parallel to the wood grain in a previous paper. Effects of cure time on bond-line parameters were compared between cure times of two and seven days. A considerable number of 7-day-cured specimens failed by dowel fractures. As a result of the theoretical curve-fit, 7-day-cured specimens showed larger Γ than 2-day-cured specimens, while fv was similar. These results suggest that polyurethane adhesive becomes stiff and strong with cure time, and dowels may fail by shear stress under the combined stress of tension. Although pull-out strengths for 16-mm dowels were slightly underestimated, the theoretical predictions for pull-out strength and stiffness were consistent with the results of specimens for 8, 12, and 16 mm diameters dowels. Withdrawal tests of post-sill joints connected with two or four 12-mm-dowels were conducted. As a result, total withdrawal strength and stiffness increased in proportion to the number of dowels.

KOMATSU, K., K. HWANG and Y. ITOU: **Static cyclic lateral loading tests on nailed plywood shear walls,** *The 32nd International Council for Research and Innovation in Building and Construction, Working Commission W18-Timber Structures, CIB-W18/32-15-4,* Graz, Austria, August, (1999).

Simplified calculation method for predicting shear deformation of the model shear resistance system in which semi-rigid jointed glulam portal frame with nailed plywood shear wall panel was proposed in this report. Load-slip relationship of nail joint, moment-rotation relationship of column leg joints and beam-column joints were all expressed in the form of 3-parameters exponential function to make nonlinear calculation possible. Coincident between observed behavior with calculated ones were good with a few exceptions. As a whole, proposed calculation method was thought to be usable for practical design purposes.

KOMATSU, K., K. HOSOKAWA and K. HAYASHI: **Shear performance of a bolted beam-column joint depending on the bearing resistance of timbers,** *Proceedings of the 3rd Timber Engineering Forum, 31–34,* Tokyo, November, (1999) (in Japanese).

A new type joist hunger which was intended to be used for the corner continuous column and beam joints in conventional wooden residential houses was developed. One of the possible hypothesis for strength revealing mechanism of the joist hunger was proposed and an allowable strength of the joist hunger was preliminary calculated based on the hypothesis. Experimental results supported that the proposed strength revealing mechanism could give a reasonable allowable strength value judging from both current building code of Japan and the design standard assigned by the Architectural Institute of Japan.

KOMATSU, K.: **Proposal of time-dependent deformation model for steel dowel joints in timber structures,** *Wood Research and Technical Notes,* No. **35**, 10–11, December, (1999).

A basic partial differential equation which might enable to derive a solution for the time-dependent deformation of steel dowels in timber structures was preliminary proposed by adding a dush-pot function on the embedment characteristics of timber.

KOMATSU, K.: **Modern timber bridges—State of the arts,** *Wood Research and Technical Notes,* No. **35**, 21–31, December, (1999).

State of the arts on modern timber bridges which have been built in Japan past decade were briefly reviewed.

KOMATSU, K.: **Mechanical fastener,** Manual for Experiments on Wood Science and Tecnology, edited by Japan Wood Research Society, Buneidou Printing Co. Ltd, 244–245 (2000).

Standard testing and evaluation methods for typical mechanical fasteners which were generally used in timber structures were proposed for the use of university student experiments.

HARADA, M., T. HAYASHI, M. KARUBE, H. TSUCHIDA, T. ZUSHI and K. KOMATSU: **Bearing tests of glued laminated timbers with drift-pins,** *Journal of the Society of Materials Science, Japan,* **49**(4), 368–372 (2000).

To investigate the accuracy of present design formulas for mechanical joints of glued laminated timbers (GLTs), dowel-bearing tests with a drift-pin were conducted in this study. GLTs with four kinds of moduli of elasticity (5.9, 7.9, 9.8, and 11.8 GPa) were prepared for the tests. These GLTs were composed of mechanically graded Japanese cedar and Japanese larch laminae with uniform modulus of elasticity. Four types of specimens were cut from these GLTs ; "Parallel type" in which load was applied parallel to the grain, and "Perpendicular type" in which load was applied perpendicular to the grain. Five kinds of drift-pins with the diameter of 4, 8, 12, 16 and 20 mm were embedded into GLTs. Bearing stress was calculated by the ratio of a bearing load to the diameter and the length of a drift-pin.

We investigated the relation of the diameter of a drift-pin to "five percent offset values" specified in ASTM-D5764, "initial stiffness" calculated by the ratio of a bearing stress

to a unit bearing deformation, and "effective elastic foundation depth" (the ratio of modulus of elasticity of wood to the initial stiffness) based on the theory of a beam on elastic foundation.

The results obtained were as follows.

(1) Five percent offset values were constant regardless of the diameter for the "Parallel type" whereas they showed a declining tendency with increasing of diameters for "Perpendicular type".

(2) Initial stiffness decreased with increasing of diameters for the "Perpendicular type", on the other hand, this tendency was not clear for the "Parallel type".

(3) Effective elastic foundation depth increased with increasing of diameters for both types. Dr. Hirai's formula commonly used to estimate the relationship between the depth and diameter of fasteners was applied to these results, however the conformability was low. This discrepancy resulted from the fact that the formula was derived from experiments in which fasteners of small diameters were used.